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An Assessment of the American Plaice Stock in NAFO Subdivision 3Ps

by

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Abstract

Sampling data from 1973-81 were reviewed and recalculation of catch numbers and weights from this period, together with values from the more recent period permitted an assessment using sequential population analysis to be performed on this stock for the first time in several years. Calibration of the analysis with commercial CPUE indicated the fully-recruited fishing mortality in 1986 to be 0.18, slightly below the $F_{0.1}$ level. Research vessel surveys in 1986 and 1987 indicate the biomass to be close to the average from 1980-87. Catch rates in the commercial fishery declined in 1986 from the very high levels observed in 1984 and 1985, but are still higher than the historical average. Catch projections, based on the sequential population analysis at F_t = 0.18, indicate the $F_{0.1}$ catch in 1988 to be 5,100 tons.

Résumé

Les données d'échantillonnage pour 1973 à 1981 ont été examinées et de nouveaux calculs des nombres et des poids des prises pour cette période, ainsi que les valeurs obtenues pour la période plus récente, ont permis d'effectuer pour la première fois depuis plusieurs années dans le cas de ce stock une évaluation au moyen de l'analyse séquentielle de population. L'étalonnage de cette analyse à l'aide des PUE commerciales indique pour 1986 une valeur de la mortalité par pêche de plein recrutement de 0,18, soit légèrement inférieure à la valeur du $F_{0,1}$. Les relevés effectués à bord de navires de recherche en 1986 et 1987 indiquent une biomasse voisine de la valeur moyenne pour la période de 1980 à 1987. Les taux de prises des pêches commerciales ont diminué en 1986 par rapport aux niveaux très élevés en 1984 et en 1985, mais sont encore plus élevés que le taux moyen historique. Les projections concernant les prises basées sur l'analyse séquentielle de population et un F_T = 0,18, indiquent une $F_{0,1}$ de 5 100 t pour 1988.

Introduction

TAC - Catch history

This stock came under quota regulation in 1974, when a TAC of 11,000 t was set, based on average catches. Since 1977, the TAC's have been between 4,000 and 6,000 t, with 5,000 t representing the level from 1980 to the present. Catches from this stock were at their highest level in the 1968-73 period, when they exceeded 12,000 t on 3 occasions (Table 1). Foreign involvement in this fishery was also at its peak during these years (Fig. 1). From 1974 onward, catches have been taken mainly by Canadian offshore otter trawlers although an inshore fishery does exist, taking 1,252 t in 1986, up from approximately 442 t, 316 t, 207 t and 384 t in the 1982-85 period. The increase in 1986 was due primarily to the 885 t taken in the gillnet sector, compared with only 106 t in 1985. After a decline in the early 1980's, the catch of plaice by Canadian offshore trawlers increased in the 1984-86 period, with peak catches from this sector occurring in the January-March period (Table 2). Preliminary estimates for 1987 show the catch in the first quarter of 1987 to be about 2,000 t, which is only slightly below the 1985 and 1986 catches from this quarter.

Assessment

Calculation of catch and weight at age, 1973-86

Because some uncertainties existed with the catch at age in earlier years, and also because weights at age were not available for some of these years (Brodie 1986), it was decided to recalculate these parameters for 1973-81 (Table 3). The catch at age for 1982-85 was taken from the 1986 assessment and adjusted to the reported catch in each year, while the 1986 catch and weights at age were calculated from port sampling of Canadian commercial catches (Table 4). The 1982-85 revisions were generally minor, although the changes to some years in the 1973-81 period were often substantial (Table 5). The weights at age for 1981 appear to be anomalous and warrant further investigation. A check of the cross products (sum of wt. at age times catch at age) for the 1973-81 values showed excellent agreement with the nominal catches in each year, with the exception of 1974, where the cross product was 1097 t or 17% greater than the landings. Table 6 shows the weight at age matrix, with the 1973-81 values being obtained from the recalculations, the 1982-85 values from the 1983-86 assessments of this stock, and the 1986 values from Table 4.

Catch/effort data

The 1986 assessment of this stock presented a CPUE series for Canadian offshore trawlers, TC 4 and 5, which showed a sharp increase in catch rate from 1983 to 1984 and again from 1984 to 1985. This series did not account for possible seasonal variability in the CPUE data, although a correction was applied to equate side trawler effort with stern trawler effort. At the

recommendation of CAFSAC's Groundfish Subcommittee, the multiplicative model of Gavaris (1980) was used to estimate a CPUE series. Data from 1974 to 1986 were used in the model, with NAFO data prior to 1974 being unavailable in the format required, i.e. from catches coded as main species plaice. Only data from Canada were present in sufficient amounts, with Newfoundland and Maritime or Maritime/Quebec taken as separate categories. As is the norm, catches less than 10 t and effort less than 10 hrs were not included in this analysis. Because of uncertainty with prorating of effort data, an unweighted regression was used, rather than weighting with a vector such as log (catch X effort). The results of the catch rate standardization are shown in Table 7, and the CPUE series is plotted, along with the "old" series, in Fig. 2. Clearly, the increase in CPUE from 1983 to 1985 was not caused by seasonal variability in the catch rates, although the magnitude of the increase is smaller in the multiplicative model series. There is a decline in CPUE in 1986, with this point approximating the level indicated by the multiplicative model in 1982-83. Interestingly, there is a wide discrepancy between the 1982-83 and 1986 points in the old series (Fig. 2). It is also interesting to note that the model shows that CPUE for this stock is slightly higher in the July-August period compared to the January-March period, given that the effort is often concentrated in the early part of the year, particularly in 1984-86. In any case, it is obvious that CPUE for this stock increased slightly from the mid 1970's to early 1980's, rose sharply in 1984 and 1985, then declined in 1986, to a level which was still higher than that of the 1974-81 period.

Research vessel survey data

Stratified random surveys have been conducted in Subdiv. 3Ps in each year from 1972 to 1986, using the stratification scheme shown in Fig. 4. Table 8 shows the results from these surveys, and it can be seen that the survey coverage was incomplete in many years prior to 1979, that few strata are common to all surveys, and that large fluctuations occur in the biomass estimates, even between years with relatively equivalent survey coverage, e.g. the 1983-86 period (Brodie, 1985). To attempt to account for inconsistent survey coverage and the fact that different vessel-gear combinations were used in the surveys pre and post-1983, numbers at age, adjusted for differences in vessel fishing power, were calculated for the 1973-86 surveys from selected strata (Tables 9-10). The conversion factors used for the different vessels were from Gavaris and Brodie, 1984, and are different for Am. plaice less than 28 cm and Am. plaice greater than or equal to 28 cm. Figure 3 shows the trend in the total numbers per tow from the selected strata, although it should be noted that this may not be representative of the stock as a whole, in that in some years, less than a third of the Subdiv. 3Ps plaice biomass has been found in these selected strata.

The survey results from 1983 to 1987 are noteworthy in that they were obtained with the same vessel-gear types and coverage is virtually complete in the important strata in each year. The 1985 biomass estimate of 64,000 t (Table 8) is much higher than the surrounding values, and this is caused largely by an estimate of about 19,000 t in stratum 317. Two large catches of plaice in this stratum produced this estimate, which is many times higher than the biomass in this stratum in other surveys. In addition, these fish were much larger than average, as can be seen from the population sizes at ages 12+ in 1985 (Table 10) and the average fish size of about 2.0 kg in the selected

strata estimates (Table 11). Although the commercial CPUE was also at its highest point in 1985, the catches did not contain the proportions of older fish indicated by the survey (Table 5), eg. ages 12+ accounted for 71% of the 6+ survey numbers, but only 27% of the 6+ catch numbers. In any event, the two surveys after 1985 gave biomass estimates for Subdiv. 3Ps of between 30,000 and 34,000 t (Table 8).

Partial recruitment vector

To obtain a PR vector for use in sequential population analysis (SPA), a standard iterative procedure was used. The PR vector used in the last SPA done on this stock (Brodie and Pitt, 1981) was input into a preliminary SPA run at F_t=0.25, and the resulting fishing mortalities for 1983-86 were averaged across ages, creating a new PR. This procedure continued until the output PR differed only marginally from the previous input values. The resulting PR (Table 12) shows higher selectivity at ages 8+, with full recruitment indicated at age 11, as opposed to age 13 in the 1981 PR series.

Mortality estimates

Z-values from several sources were calculated for this stock (Table 13). Catch curves, based on research vessel survey data, gave Z-values in the range of 0.21 to 0.43 (Fig. 5), while a similar calculation for the 1986 commercial catch at age yielded a figure of 0.71. Paloheimo Z-values, based on commercial catch at age per 10 hours of effort, were around 0.9 for 1986/85, compared to a range of about 0.3 to 0.75 for 1985/84. Because of the very high catch numbers per tow at the older ages in the 1985 survey (Table 9), survival estimates based on 1985/84 vs 1986/85 are completely different, i.e. negative Z values for 1985/84, Z=1.5 for 1986/85.

Sequential population analysis

Using the catch and weight at age and PR described previously, along with natural mortality of 0.2 and fishing mortalities at age 19 averaged from ages 16 to 19 in a preliminary SPA, a series of SPA was done over a range of terminal F values in 1986. Calibration of exploitable biomass with CPUE was rejected because of uncertainties about the partial recruitment pattern in some years, eg. large fluctuations occurred in the PR pattern between years and these were not explainable by events occurring in the fishery or the population. As well, calibration using age 6+ biomass from SPA vs total biomass from research vessel surveys using the years 1980-86, was not useful in determining F in 1986, mainly because of large variations in recent survey estimates.

The relationship between 8+ biomass from SPA and CPUE was examined for the years 1974-86, excluding 1984 and 85. These 2 years were excluded because the CPUE values were much higher than any others, and these two points, particularly 1985, were very influential in determining the relationship. It was concluded that the regression line through the remaining points, with an intercept of zero, was the suitable criterion for determining the 1986 fishing mortality. This relationship indicated a fully recruited F in 1986 of 0.18 (Table 14, Fig. 6).

Discussion

The assessment indicates that the 8+ biomass for this stock decreased from about 20,000-25,000 t in 1973-75 to an average of about 16,500 t in 1976-81, and has increased gradually to about 29,000 t in 1986. Fishing mortalities in the 1983-86 period appear to have been slightly below the $F_{0.1}$ level (Table 15).

The projection parameters used are shown in Table 16. The geometric mean value, 1973-80, at age 6 was used to represent the size of the 1981 and 1982 year-classes at age 6 in the projection. The partial recruitment values represent the average over the 1982-85 period as indicated by the SPA, and are lower at ages 8 - 10 than the values used in the SPA for the 1986 population.

Assuming that the TAC of 5,000 t will be taken in 1987, generating a fully recruited F of 0.23, the 1988 catch at $F_{0.1}$ = 0.25 is projected to be 5,100 t (Table 17). With a catch in 1987 at $F_{0.1}$ of 5,300 t, the 1988 catch at $F_{0.1}$ is projected to be 5,000 t.

References

Brodie, W. B. 1985. An assessment of American plaice in NAFO Subdivision 3Ps. CAFSAC Res. Doc. 85/54. 13 p.

Brodie, W. B. 1986. Status of the American plaice stock in NAFO Subarea 3Ps. CAFSAC Res. Doc. 86/34. 16 p.

Brodie, W. B., and T. K. Pitt. 1981. An assessment of American plaice in Subdivision 3Ps. CAFSAC Res. Doc. 81/37. 14 p.

Gavaris, S. 1980. Use of a multiplicative model to estimate catch rate and effort from commercial data. Can. J. Fish. Aquat. Sci. 37: 2272-2275.

Gavaris, S. and W. B. Brodie. 1984. Results of Comparative fishing between the A. T. CAMERON and the WILFRED TEMPLEMAN during July-August 1983. CAFSAC Res. Doc. 84/41. 16 p.

Table 1. Catches and TAC's (tons) of American plaice in NAFO Subdivision 3Ps, 1960-86.

Year	Canada [Nfld.	M&Q	Total]	France	USSR	Other	Total	TAC
1960	422	405	827	60	-	-	887	-
1961	764	660	1424	31	-	-	1455	-
1962	659	363	1022	2	-	-	1024	-
1963	504	25	529	208	1	16	754	-
1964	1132	230	1362	152	-	28	1542	-
1965	574	1275	1849	162	-	11	2022	-
1966	1162	1332	2494	667	218	27	3406	-
1967	2201	1074	3275	533	678	8	4494	-
1968	4007	1516	5523	524	8233	-	14280	-
1969	2888	1178	4066	245	2180	-	6491	-
1970	7368	4227	11595	397	336	-	12328	-
1971	4667	1286	5953	820	409	-	7182	-
1972	4301	1621	5922	383	220	13	6538	-
1973	10972	1840	12812	547	1368	42	14769	-
1974	5887	443	6330	268	-	-	6598	11,000
1975	2517	1301	3818	65	128	200	4211	11,000
1976	5302	128	5430	5	9	14	5458	8,000
1977	4235	307	4542	63	-	-	4605	6,000
1978	3419	192	3611	47	-	-	3658	4,000
1979	3405	187	3592	74	-	-	3666	4,000
1980	2516	213	2729	206	-	-	2935	5,000
1981	2703	57	2760	457	-	-	3217	5,000
1982	1823	46	1869	317	-	-	2186	5,000
1983	1421	83	1504	222	-	-	1726	5,000
1984	2487	138	2625	338	-	-	2963	5,000
1985[a]	3589	206	3795	406	-	-	4201	5,000
1986[a]	4339	109	4448	-	-	1	4449	5,000
1987								5,000

[a]Provisional.

Table 2. Nominal catch by month, American plaice in Subdivision 3Ps, 1972-86.

Year	Jan.	Feb	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	UNK	Total
1972	1118	105	311	161	110	109	391	520	604	880	1044	1185	-	6538
1973	1681	500	2599	1527	96	350	969	2607	931	504	2237	768	-	14769
1974	162	133	1576	2575	123	137	165	399	567	128	364	269	-	6598
1975	6	6	1495	616	332	280	186	115	120	82	441	532	-	4211
1976	98	254	461	191	91	284	439	512	353	433	984	1358	-	5458
1977	28	547	663	339	309	287	414	204	105	261	712	736	-	4605
1978	250	141	185	1066	853	121	433	427	40	41	55	46	-	3658
1979	467	376	1086	212	189	262	225	265	124	161	246	53	-	3666
1980	14	464	180	63	216	359	166	170	170	191	256	686	-	2935
1981	423	57	236	371	363	331	302	156	214	263	273	228	-	3217
1982	53	4	285	315	181	156	133	195	125	95	463	181	-	2186
1983	98	47	161	71	61	155	169	91	327	372	149	25	-	1726
1984	128	1933	101	43	125	126	85	60	31	194	94	43	-	2963
1985[a]	3	55	2814	231	34	153	129	80	198	145	342	17	-	4201
1986[a]	1954	448	497	29	94	297	260	478	235	68	35	54	-	4449

[a]Provisional.

Table 3. Recalculated catch and weight at age, with associated statistics, for A. plaice in the commercial fishery, 1973-81, Subdivision 3Ps.

1973

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
7	0.291	32.248	11	8.27	0.74
8	0.367	34.585	864	137.42	0.16
9	0.481	37.467	2874	249.02	0.09
10	0.652	41.062	4516	331.53	0.07
11	0.877	44.908	4207	332.13	0.08
12	1.183	49.126	2433	249.28	0.10
13	1.448	52.177	1095	163.23	0.15
14	1.819	55.937	667	110.81	0.17
15	2.260	59.736	294	67.77	0.23
16	2.641	62.578	125	40.06	0.32
17	3.103	65.685	66	29.36	0.45
18	3.212	66.442	19	12.25	0.65
19	3.636	69.000	4	5.34	1.27

1974

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
* 5	0.236	30.249	37	20.28	0.55
6	0.291	32.163	326	75.96	0.23
7	0.360	34.268	903	125.74	0.14
8	0.434	36.116	889	134.63	0.15
9	0.539	38.614	1140	148.66	0.13
10	0.713	42.090	1263	152.38	0.12
*11	0.888	44.983	717	113.01	0.16
*12	1.149	48.646	792	105.32	0.13
13	1.424	51.945	801	89.08	0.11
14	1.846	56.157	422	64.91	0.15
15	2.065	58.085	186	41.06	0.22
16	2.612	62.374	198	40.07	0.20
17	2.602	62.287	132	35.78	0.27
18	3.247	66.480	137	33.21	0.24
*19	3.834	70.028	57	24.95	0.44
20	3.297	67.000	5	3.49	0.72
21	3.297	67.000	2	2.50	1.03

1975

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
* 5	0.226	29.808	65	23.84	0.37
6	0.292	32.221	391	58.80	0.15
7	0.400	35.373	839	113.29	0.14
8	0.538	38.660	721	122.62	0.17
9	0.586	39.650	644	103.80	0.16
10	0.791	43.451	383	76.81	0.20
11	0.885	44.883	423	78.76	0.19
*12	1.263	49.952	490	62.59	0.13
13	1.414	51.746	361	53.65	0.15
*14	1.673	54.461	258	47.08	0.18
15	2.058	58.094	61	15.38	0.25
16	2.402	60.806	91	19.69	0.22
17	2.686	62.846	79	19.71	0.25
*18	3.043	65.111	51	15.32	0.30
*19	2.969	64.574	44	14.89	0.34
*20	3.441	67.513	15	6.47	0.43
21	3.297	67.000	3	3.36	1.07
22					
23	5.236	77.000	3	3.34	1.26

1976

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
* 4	0.124	25.000	1	0.02	0.02
* 5	0.217	29.258	7	3.37	0.50
* 6	0.300	32.486	121	24.04	0.20
* 7	0.352	34.027	445	48.51	0.11
* 8	0.439	36.289	1117	88.09	0.08
9	0.546	38.758	1514	101.37	0.07
10	0.653	40.925	1266	92.06	0.07
11	0.829	44.043	979	75.90	0.08
12	1.035	47.079	715	62.02	0.09
*13	1.281	50.204	460	45.64	0.10
14	1.523	52.939	223	30.46	0.14
*15	1.736	54.929	162	24.72	0.15
*16	2.041	57.707	127	20.72	0.16
17	2.435	60.773	50	12.54	0.25
*18	3.012	65.031	41	9.42	0.23
19	3.439	67.837	2	2.15	0.86
20	3.998	71.000	1	1.71	1.18
21	3.998	71.000	1	1.71	1.18

1977

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
* 5	0.102	23.206	3	0.04	0.01
* 6	0.264	31.076	18	5.17	0.29
7	0.317	32.905	133	21.47	0.16
* 8	0.347	33.783	330	38.45	0.12
9	0.435	36.134	803	60.28	0.08
10	0.647	40.508	905	69.35	0.08
11	0.777	42.982	952	63.48	0.07
*12	1.048	47.057	343	37.00	0.11
*13	1.408	51.528	288	36.77	0.13
14	1.611	53.582	245	34.29	0.14
15	1.835	55.766	223	33.94	0.15
16	2.071	57.821	235	33.36	0.14
17	2.361	59.988	157	24.14	0.15
*18	2.736	63.104	102	17.85	0.17
*19	3.243	66.386	34	9.68	0.28
*20	3.844	70.125	12	5.43	0.47
21	3.634	68.887	8	4.86	0.59

Table 3 Cont'd.

1978

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
5	0.161	27.000	1	1.40	1.28
* 6	0.311	32.664	49	17.55	0.36
7	0.322	33.071	196	39.48	0.20
8	0.388	34.782	482	63.84	0.13
9	0.491	37.559	964	90.69	0.09
10	0.575	39.294	1011	99.19	0.10
11	0.814	43.519	756	90.99	0.12
12	0.976	45.791	726	81.62	0.11
*13	1.145	47.994	324	50.38	0.16
14	1.239	48.871	225	37.08	0.16
15	1.770	54.785	123	28.63	0.23
*16	2.478	61.190	75	16.59	0.22
17	2.698	62.416	20	7.86	0.38
18	2.736	63.173	11	7.60	0.68
*19	4.120	71.424	6	1.02	0.16
20					
21					
22					
23					
24					
*25	6.196	81.000	3	0.05	0.02

1979

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
* 4	0.204	29.000	1	0.91	0.69
5	0.251	30.856	9	3.51	0.38
6	0.366	34.492	130	25.56	0.20
7	0.448	36.564	240	41.25	0.17
8	0.474	36.996	574	59.43	0.10
9	0.585	39.356	908	70.12	0.08
10	0.761	42.448	820	64.04	0.08
11	1.026	46.501	608	50.24	0.08
12	1.335	50.540	349	36.68	0.11
13	1.784	55.275	225	29.85	0.13
*14	2.147	58.623	149	23.81	0.16
*15	2.387	60.545	117	20.10	0.17
16	2.981	64.853	43	10.69	0.25
17	3.207	66.229	23	7.54	0.33
18	2.981	65.000	3	2.69	1.01

1980

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
* 6	0.161	27.000	2	0.05	0.03
* 7	0.332	33.477	121	42.64	0.35
* 8	0.390	35.046	491	63.63	0.13
9	0.491	37.479	737	85.56	0.12
10	0.571	39.082	725	85.91	0.12
*11	0.787	43.030	600	70.01	0.12
12	0.974	45.814	545	61.58	0.11
13	1.358	50.799	364	38.39	0.11
*14	2.086	58.050	71	14.14	0.20
15	2.099	57.937	81	15.27	0.19
16	2.523	61.514	50	10.23	0.20
17	2.977	64.905	23	6.31	0.27
18	3.186	66.226	14	5.22	0.37
19					
20	3.998	71.000	1	1.48	1.35

1981

AGE	AVERAGE WEIGHT	AVERAGE LENGTH	CATCH MEAN	CATCH STD. ERR.	CATCH C. V.
4	0.204	29.000	1	1.28	1.12
5	0.285	32.010	22	10.67	0.50
6	0.349	34.014	52	17.06	0.33
7	0.452	36.529	281	39.69	0.14
8	0.505	37.579	628	54.24	0.09
9	0.501	37.493	884	60.84	0.07
10	0.646	40.508	512	47.08	0.09
*11	0.765	42.731	375	36.98	0.10
12	0.937	45.192	257	24.91	0.10
*13	0.894	44.449	288	22.85	0.08
*14	0.958	45.829	360	25.11	0.07
15	1.194	49.188	339	23.51	0.07
*16	1.662	54.222	142	16.23	0.11
17	1.904	56.686	103	12.76	0.12
18	2.269	59.817	38	7.21	0.19
19	2.707	63.081	20	4.53	0.23
*20	3.264	66.647	12	3.24	0.27
21	3.636	69.000	1	1.17	0.81

Table 4a. List of commercial sampling by quarter available for 1986, for American plaice in Subdivision 3Ps.

	Quarter				
	1	2	3	4	Total
Can(N) Offshore catch (t)	2858	96	89	45	3088
Samples	18	-	1	-	19
Measured	6714	-	414	-	7128
Otoliths	899	-	93	-	992
Can(N) Inshore catch (t)	-	78	888	285	1251
Samples	-	-	1	-	1
Measured	-	-	262	-	262
Otoliths	-	-	77	-	77

Table 4b) Catch and weight at age, with associated statistics, for A. plaice in the commercial fishery in 1986, Subdivision 3Ps.

	AVERAGE		CATCH		
AGE	WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.
* 6	0.291	32.135	3	1.26	0.50
7	0.361	34.364	63	9.18	0.15
8	0.448	36.677	252	22.31	0.09
* 9	0.556	39.116	449	34.74	0.08
10	0.699	41.844	737	44.94	0.06
11	0.852	44.371	1004	48.00	0.05
12	1.165	48.777	827	57.25	0.07
13	1.466	52.265	360	48.69	0.14
*14	1.870	56.265	314	27.38	0.09
15	2.322	60.099	162	17.79	0.11
16	2.844	63.841	67	9.84	0.15
17	3.574	68.566	20	3.66	0.19
*18	3.865	70.212	7	0.96	0.14
*19	5.236	77.000			0.01

Table 5a) "Old" catch matrix, 3Ps plaice, 1973-85 (taken from 1986 assessment).

AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
6	46	312	264	121	24	53	97	2	9	2	5	4	3
7	568	783	619	442	150	206	182	148	115	29	77	14	27
8	823	857	613	1110	370	498	545	609	510	193	371	109	359
9	1170	1165	570	1499	896	994	900	925	929	390	440	613	945
10	941	1221	422	1249	917	1033	845	897	539	801	620	1170	1153
11	2003	777	403	963	1055	769	654	720	429	1142	463	1223	957
12	1344	880	480	705	384	729	382	633	214	463	303	667	550
13	1272	844	401	454	280	329	241	401	114	198	237	357	275
14	1140	490	239	219	249	228	162	73	90	125	82	234	183
15	974	220	77	161	191	120	133	87	70	44	14	112	123
16	827	173	100	127	209	76	48	50	34	22	11	43	65
17	426	96	95	99	138	21	25	21	18	12	3	12	43
18	377	145	64	42	91	11	3	12	7	5	1	6	16
19	239	61	60	3	31	5	1	1	3	1	1	1	4

Table 5b) Recalculated catch matrix, 3Ps plaice, 1973-86.

AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
6	1	326	391	121	18	49	130	2	52	2	5	4	3	3
7	11	903	839	445	133	196	240	121	281	28	83	14	28	63
8	864	889	721	1117	330	482	574	491	628	186	401	107	378	252
9	2874	1140	644	1514	803	964	908	737	884	377	476	603	995	449
10	4516	1263	383	1266	905	1011	820	725	512	774	670	1151	1214	737
11	4207	717	423	979	952	756	608	600	375	1103	501	1203	1008	1004
12	2433	792	490	715	343	726	349	545	257	447	328	656	579	827
13	1095	801	361	460	288	324	225	364	288	191	256	351	290	360
14	667	422	258	223	245	225	149	71	360	121	89	230	193	314
15	294	186	61	162	223	123	117	81	339	43	15	110	130	162
16	125	198	91	127	235	75	43	50	142	21	12	42	68	67
17	66	132	79	50	157	20	23	23	103	12	3	12	45	20
18	19	137	51	41	102	11	3	14	38	5	1	6	17	7
19	4	57	44	2	34	6	1	1	20	1	1	1	4	1

PERCENT CATCH AT AGE

AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
6	0.0	4.1	8.1	1.7	0.4	1.0	3.1	0.1	1.2	0.1	0.2	0.1	0.1	0.1
7	0.1	11.3	17.3	6.2	2.8	3.9	5.7	3.2	6.6	0.8	2.9	0.3	0.6	1.5
8	5.0	11.2	14.9	15.5	6.9	9.7	13.7	12.8	14.7	5.6	14.1	2.4	7.6	5.9
9	16.7	14.3	13.3	21.0	16.8	19.4	21.7	19.3	20.7	11.4	16.8	13.4	20.1	10.5
10	26.3	15.9	7.9	17.5	19.0	20.4	19.6	19.0	12.0	23.4	23.6	25.6	24.5	17.3
11	24.5	9.0	8.7	13.6	20.0	15.2	14.5	15.7	8.8	33.3	17.6	26.8	20.4	23.5
12	14.2	9.9	10.1	9.9	7.2	14.6	8.3	14.2	6.0	13.5	11.5	14.6	11.7	19.4
13	6.4	10.1	7.5	6.4	6.0	6.5	5.4	9.5	6.7	5.8	9.0	7.8	5.9	8.4
14	3.9	5.3	5.3	3.1	5.1	4.5	3.6	1.9	8.4	3.7	3.1	5.1	3.9	7.4
15	1.7	2.3	1.3	2.2	4.7	2.5	2.8	2.1	7.9	1.3	0.5	2.4	2.6	3.8
16	0.7	2.5	1.9	1.8	4.9	1.5	1.0	1.3	3.3	0.6	0.4	0.9	1.4	1.6
17	0.4	1.7	1.6	0.7	3.3	0.4	0.5	0.6	2.4	0.4	0.1	0.3	0.9	0.5
18	0.1	1.7	1.1	0.6	2.1	0.2	0.1	0.4	0.9	0.2	0.0	0.1	0.3	0.2
19	0.0	0.7	0.9	0.0	0.7	0.1	0.0	0.0	0.5	0.0	0.0	0.0	0.1	0.0

Table 5c) Difference between old and new catch matrices.

AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
6	45	-14	-127	0	6	4	-33	0	-43	0	0	0	0
7	557	-120	-220	-3	17	10	-58	27	-166	1	-6	0	-1
8	-41	32	-108	-7	40	16	-29	118	-118	7	-30	2	-19
9	-1704	25	-74	-15	93	30	-8	188	45	13	-36	10	-50
10	-3575	-42	39	-17	12	22	25	172	27	27	-50	19	-61
11	-2204	60	-20	-16	103	13	46	120	54	39	-38	20	-51
12	-1089	88	-10	-10	41	3	33	88	-43	16	-25	11	-29
13	177	43	40	-6	-8	5	16	37	-174	7	-19	6	-15
14	473	68	-19	-4	4	3	13	2	-270	4	-7	4	-10
15	680	34	16	-1	-32	-3	16	6	-269	1	-1	2	-7
16	702	-25	9	0	-26	1	5	0	-108	1	-1	1	-3
17	360	-36	16	49	-19	1	2	-2	-85	0	0	0	-2
18	358	8	13	1	-11	0	0	-2	-31	0	0	0	-1
19	235	4	16	1	-3	-1	0	0	-17	0	0	0	0

Table 6. Weights at age (kg), 3Ps plaice, from the commercial fishery, 1973-86.

AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
6	0.291	0.291	0.292	0.300	0.264	0.311	0.366	0.161	0.349	0.303	0.286	0.278	0.204	0.291
7	0.291	0.360	0.400	0.352	0.317	0.322	0.448	0.332	0.452	0.425	0.415	0.303	0.273	0.361
8	0.367	0.434	0.538	0.439	0.347	0.388	0.474	0.390	0.505	0.419	0.459	0.357	0.358	0.448
9	0.481	0.539	0.586	0.546	0.435	0.491	0.585	0.491	0.501	0.448	0.558	0.421	0.484	0.556
10	0.652	0.713	0.791	0.653	0.647	0.575	0.761	0.571	0.646	0.513	0.672	0.515	0.647	0.699
11	0.877	0.888	0.885	0.829	0.777	0.814	1.026	0.787	0.765	0.656	0.714	0.638	0.884	0.852
12	1.183	1.149	1.263	1.035	1.048	0.976	1.335	0.974	0.937	0.924	0.856	0.841	1.214	1.165
13	1.448	1.424	1.414	1.281	1.408	1.145	1.784	1.358	0.894	1.184	0.948	1.074	1.524	1.466
14	1.819	1.846	1.673	1.523	1.611	1.239	2.147	2.086	0.958	1.541	1.507	1.314	1.907	1.870
15	2.260	2.065	2.058	1.736	1.835	1.770	2.387	2.099	1.194	1.978	1.924	1.766	2.356	2.322
16	2.641	2.612	2.402	2.041	2.071	2.478	2.981	2.523	1.662	2.339	2.416	2.423	2.739	2.844
17	3.103	2.602	2.686	2.435	2.361	2.698	3.207	2.977	1.904	2.739	2.858	2.610	3.222	3.574
18	3.212	3.247	3.043	3.012	2.736	2.736	2.981	3.186	2.269	3.329	3.733	3.116	3.454	3.865
19	3.636	3.834	2.969	3.439	3.243	4.120	3.207	3.186	2.707	3.659	4.798	3.297	3.636	5.236

Table 7. Regression coefficients and analysis of variance from the regression of ln catch rate of A. plaice in Subdivision 3Ps for the years 1974-86.

Country-Gear-TC	Ln Power	Month	Ln Power
Can(N) OT Side 4	-0.216	May	-0.688
Can(N) OT Stern 4		June, September, October, November	-0.404
Can(M, MQ) OT Stern 5			
Can(N) OT Stern 5	0.000		
Can(MQ) OT Side 4			
		April	-0.247
		December	-0.129
		January, February, March	0.000
		August	0.004
		July	0.112

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... 0.723
MULTIPLE R SQUARED..... 0.522

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	2.792E2	2.792E2	
REGRESSION	19	2.995E1	1.576E0	13.336
TYPE 1	1	2.726E0	2.726E0	23.065
TYPE 2	6	1.172E1	1.953E0	16.521
TYPE 3	12	1.249E1	1.041E0	8.809
RESIDUALS	232	2.742E1	1.182E-1	
TOTAL	252	3.366E2		

REGRESSION COEFFICIENTS

VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
INTERCEPT	-0.835	0.076	252
1	-0.216	0.045	111
2	-0.247	0.075	33
3	-0.688	0.098	16
4	-0.404	0.058	82
5	0.112	0.103	14
6	0.004	0.088	21
7	-0.129	0.089	21
8	0.069	0.099	20
9	-0.157	0.092	26
10	-0.012	0.090	28
11	-0.092	0.097	23
12	0.058	0.091	27
13	-0.062	0.098	21
14	0.137	0.101	19
15	0.365	0.107	16
16	0.229	0.112	14
17	0.626	0.138	8
18	0.899	0.137	8
19	0.322	0.123	11

PREDICTED CATCH RATE

YEAR	LN TRANSFORM MEAN	LN TRANSFORM S.E.	RETRANSFORMED MEAN	RETRANSFORMED S.E.	CATCH	EFFORT
1974	-0.8353	0.0057	0.459	0.035	6598	14376
1975	-0.7661	0.0082	0.491	0.045	4211	8573
1976	-0.9922	0.0066	0.392	0.032	5458	13919
1977	-0.8468	0.0061	0.454	0.035	4605	10152
1978	-0.9270	0.0075	0.418	0.036	3658	8744
1979	-0.7769	0.0064	0.486	0.039	3666	7537
1980	-0.8971	0.0081	0.431	0.039	2935	6811
1981	-0.6987	0.0083	0.525	0.048	3217	6122
1982	-0.4705	0.0099	0.660	0.066	2186	3314
1983	-0.6062	0.0107	0.576	0.059	1726	2998
1984	-0.2098	0.0158	0.854	0.107	2963	3471
1985	0.0642	0.0161	1.122	0.142	4201	3743
1986	-0.5136	0.0115	0.631	0.068	4449	7048

Table 8. Mean weight (kg) of American plaice per tow, by stratum, from R. V. surveys in Subdivision 3Ps. Numbers in parentheses are the number of successful 30 minute tows in each stratum. The stratified mean weight per tow and the biomass estimates are given at the bottom of the table. (ATC, AN, WT, refers to the research vessels, A.T. CAMERON, A. NEEDLER and W. TEMPLEMAN respectively). Strata marked with an asterisk were used in the calculation of abundance and biomass in Tables 9, 10 and 11.

Depth (fm)	Stratum	Year - Survey															
		1972 ATC 197	1973 ATC 207	1974 ATC 221	1975 ATC 234	1976 ATC 247	1977 ATC 261	1978 ATC 275	1979 ATC 287	1980 ATC 302	1981 ATC 316	1982 ATC 330	1983 AN 9	1984 AN 26	1985 WT 26	1986 WT 45	1987 WT 55,56
101-150	306	-	-	0.3(6)	0.4(4)	0.6(2)	0.5(6)	1.0(6)	1.4(5)	1.1(2)	0.6(3)	0.5(3)	0.2(4)	0.1(2)	2.7(2)	0.6(3)	0.2(4)
51-100	307*	0.0(3)	0.0(5)	1.9(7)	0.4(4)	1.4(4)	1.1(4)	0.1(4)	0.1(4)	1.6(2)	0.9(3)	2.5(4)	1.3(4)	0.0(2)	0.1(3)	1.0(3)	0.4(3)
31-50	308*	-	0.7(2)	28.1(2)	17.3(4)	16.3(2)	18.8(4)	-	0.7(4)	4.0(2)	306.5(2)	49.3(2)	101.2(3)	1.5(2)	3.7(2)	0.0(2)	0.0(2)
101-150	309*	0.0(2)	1.2(3)	0.1(4)	2.6(6)	0.5(3)	1.1(6)	1.3(6)	3.9(6)	0.7(2)	1.5(2)	0.4(2)	0.3(3)	7.3(2)	1.6(3)	0.2(2)	0.5(2)
101-150	310*	-	-	0.2(3)	1.5(6)	-	0.3(6)	0.5(6)	1.7(6)	3.0(2)	3.0(2)	1.0(3)	0.2(3)	0.5(2)	4.2(3)	2.0(2)	3.5(2)
51-100	311*	8.1(4)	109.1(9)	13.4(8)	8.8(4)	12.6(6)	3.9(4)	5.9(4)	40.4(4)	108.5(2)	10.0(2)	2.7(3)	2.0(3)	2.6(2)	16.2(4)	77.0(3)	27.0(2)
31-50	312	249.5(2)	-	43.3(2)	18.4(3)	20.6(5)	12.5(4)	-	0.1(3)	-	1.2(2)	5.3(2)	12.2(3)	0.6(2)	1.5(2)	4.0(2)	2.8(2)
101-150	313*	0.5(2)	168.3(2)	0.7(5)	0.4(3)	1.2(3)	0.5(10)	4.1(2)	4.0(5)	2.6(2)	21.5(2)	1.2(2)	2.9(3)	0.7(2)	0.9(2)	9.7(2)	1.6(2)
0-30	314	28.6(2)	-	0.2(2)	-	1.1(2)	16.3(4)	-	-	0.5(2)	0.3(5)	23.3(5)	11.9(7)	5.3(4)	0.5(7)	2.0(8)	6.0(5)
31-50	315	71.7(2)	48.3(2)	103.0(2)	-	32.7(2)	27.2(4)	-	5.3(3)	48.1(4)	33.0(2)	53.5(3)	61.4(8)	35.3(5)	40.9(7)	62.5(6)	33.1(8)
101-150	316*	3.2(2)	23.0(3)	0.4(6)	-	0.8(4)	3.7(6)	4.0(6)	12.0(3)	7.5(2)	18.9(2)	-	5.3(4)	1.7(2)	3.8(3)	7.0(2)	196.8(3)
51-100	317*	64.9(4)	161.7(7)	30.2(8)	9.9(4)	5.1(4)	1.4(4)	51.3(4)	249.6(3)	318.4(2)	56.0(2)	34.2(3)	52.0(3)	6.0(2)	1312.8(2)	29.3(2)	80.0(3)
101-150	318*	-	134.3(2)	1.8(2)	0.0(4)	1.9(2)	0.7(6)	10.9(2)	3.9(2)	8.9(2)	-	0.3(2)	3.6(3)	7.3(2)	-	7.0(2)	37.1(2)
51-100	319*	14.0(4)	15.6(5)	61.2(2)	11.8(4)	63.0(4)	48.6(6)	34.2(4)	8.1(2)	39.3(4)	79.5(2)	33.0(7)	112.1(7)	43.3(6)	26.5(2)	27.1(8)	104.3(9)
0-30	320	-	2.7(2)	-	-	11.2(3)	-	-	-	12.3(6)	7.0(2)	18.8(4)	34.0(14)	9.4(8)	38.3(5)	17.0(9)	7.0(11)
31-50	321	90.5(2)	3.4(2)	-	-	88.5(2)	-	-	-	30.5(5)	45.5(2)	27.3(4)	47.2(10)	28.0(6)	23.1(7)	26.9(10)	21.8(10)
51-100	322	-	-	-	-	75.1(4)	-	-	2.8(2)	67.1(8)	21.5(2)	58.0(8)	71.2(11)	64.3(8)	179.2(13)	55.5(12)	22.9(10)
51-100	323	222.6(3)	-	-	-	111.0(4)	34.5(2)	-	-	162.5(3)	108.5(2)	256.5(2)	125.7(6)	44.4(4)	68.0(3)	170.5(5)	164.8(6)
51-100	324	-	-	-	-	53.6(2)	-	-	4.0(2)	26.8(2)	-	71.3(2)	91.5(4)	15.5(3)	202.3(2)	7.5(5)	95.7(4)
31-50	325	-	-	-	-	60.4(2)	-	-	2.7(2)	7.7(4)	4.6(2)	41.4(5)	53.4(8)	27.0(5)	25.7(3)	6.5(8)	1.6(6)
31-50	326	-	-	-	-	-	-	-	15.7(2)	13.9(2)	1.9(2)	44.3(2)	40.8(3)	29.8(2)	-	8.0(2)	14.3(2)
151-200	705	0.9(2)	1.4(2)	0.8(4)	0.3(2)	2.2(2)	1.1(4)	0.2(3)	2.8(4)	0.5(2)	0.9(2)	0.6(2)	0.5(3)	0.4(2)	3.5(2)	2.2(2)	3.5(2)
151-200	706	4.4(2)	8.2(2)	2.2(7)	-	-	3.1(4)	1.6(2)	5.6(3)	1.4(2)	6.8(2)	0.6(4)	1.9(5)	0.3(2)	1.8(4)	7.3(4)	9.7(5)
151-200	707	14.9(2)	-	0.0(2)	0.4(4)	0.1(2)	0.0(4)	3.6(2)	2.1(2)	4.5(2)	-	-	0.0(3)	8.1(2)	-	4.0(2)	1.0(2)
201-300	708	-	-	-	0.0(3)	-	0.2(4)	-	0.5(2)	0.6(2)	-	-	0.2(2)	1.4(2)	-	3.6(2)	1.5(2)
301-400	709	-	-	-	-	-	-	-	-	-	-	-	0.2(2)	0.0(2)	-	-	-
301-400	710	-	-	-	-	-	-	-	-	-	-	-	0.0(3)	2.5(2)	1.3(2)	0.7(2)	-
201-300	711	-	-	-	-	-	-	-	-	0.2(2)	0.7(2)	0.0(2)	0.8(8)	0.9(5)	1.0(8)	1.4(9)	2.2(7)
201-300	712	-	-	-	-	-	-	-	1.4(2)	0.0(2)	0.2(2)	0.0(3)	0.9(7)	-	1.0(6)	0.4(9)	0.3(4)
201-300	713	-	-	-	0.6(3)	-	-	-	-	0.2(2)	0.9(6)	0.3(2)	0.4(7)	-	0.4(8)	0.1(5)	1.0(4)
201-300	714	-	-	-	-	-	-	0.0(2)	-	1.0(2)	0.1(8)	0.0(6)	0.3(10)	-	-	8.8(5)	0.5(4)
151-200	715	0.0(2)	-	0.0(4)	0.0(2)	0.2(2)	0.2(4)	0.3(4)	0.4(3)	0.5(2)	0.3(2)	0.2(2)	0.8(3)	0.0(2)	-	1.8(2)	0.4(2)
151-200	716	0.0(2)	-	0.1(3)	-	-	0.9(6)	0.4(4)	2.1(4)	0.5(2)	1.8(4)	0.4(2)	1.5(4)	0.2(3)	4.2(5)	1.8(4)	3.8(3)
Mean (No. sets)		56.8(42)	26.8(48)	25.2(79)	5.1(60)	42.3(66)	15.8(102)	8.6(61)	9.5(78)	27.8(80)	21.0(71)	30.7(91)	34.5(171)	20.8(95)	54.9(110)	23.2(144)	25.9(134)
Biomass (t)		33,826	13,654	12,999	1,901	37,757	9,109	3,785	7,236	35,776	25,974	39,076	45,200	22,549	64,494	30,450	33,923

Table 9. Mean number of American plaice per tow from R.V. surveys in NAFO Subdivision 3Ps. The same strata were used in the calculations for each year.

Age	ATC207 1973	ATC221 1974	ATC234 1975	ATC247 1976	ATC261 1977	ATC275 1978	ATC287 1979	ATC302 1980	ATC316 1981	ATC330 1982	AN9 1983	AN26 1984	WT26 1985	WT45 1986
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	0.03	0.66	0.02		0.03	-	0.16	0.90	0.18	0.09	0.01	-	-	-
3	3.74	4.47	1.04	0.55	0.18	1.33	0.56	4.24	1.97	1.29	0.22	-	-	0.12
4	7.62	8.89	2.70	7.23	0.74	1.46	2.98	5.56	8.76	3.65	0.96	0.11	0.12	0.52
5	15.57	11.97	4.89	10.96	5.86	6.78	7.79	16.71	10.88	4.26	4.40	0.23	0.47	1.13
6	25.58	7.52	4.52	18.10	5.27	10.05	12.43	27.99	17.43	4.80	12.25	1.38	1.09	3.86
7	23.41	7.17	3.08	9.58	7.99	9.03	24.41	61.61	29.84	6.51	17.81	3.31	1.48	5.75
8	14.29	5.42	2.25	8.80	6.16	8.03	14.60	43.02	33.89	7.34	20.05	4.99	1.40	5.53
9	12.62	6.76	0.75	6.81	4.15	8.23	6.88	23.65	19.01	8.64	19.45	5.05	2.17	3.67
10	10.27	4.90	0.78	7.21	2.68	3.69	2.38	13.98	6.45	4.62	9.85	4.61	3.63	2.73
11	6.37	4.28	0.71	4.70	1.74	3.94	2.20	5.09	1.48	1.83	5.84	2.70	5.05	1.84
12	3.08	4.49	0.74	1.91	0.64	2.81	2.09	2.94	1.27	1.53	2.05	1.32	5.16	1.89
13	3.96	3.45	0.37	0.91	0.10	1.32	1.21	1.35	1.46	0.77	1.24	0.53	5.82	1.57
14	2.50	0.65	0.16	0.33	0.24	0.46	0.84	0.51	1.77	0.60	0.68	0.39	5.12	0.92
15	2.16	1.42	0.13	0.29	0.10	0.16	0.66	0.02	0.45	0.23	0.51	0.19	6.38	0.99
16	1.14	0.25	0.17	0.35	0.06	0.44	0.42	0.23	0.70	0.12	0.59	0.05	5.76	0.57
17	0.75	0.43	0.04	0.05	0.02	0.10	0.07	0.01	0.23	0.06	0.14	0.02	3.66	0.16
18	0.61	0.11	0.05	0.09	0.01	-	-	0.03	0.47	0.11	0.09	0.02	4.19	0.07
19	0.25	0.14	0.02	0.01	0.01	-	-	-	0.49	0.02	0.06	-	0.26	0.01
20	0.08	0.03	-	0.03	-	-	-	-	-	0.02	-	-	0.13	-
21	0.18	-	-	-	-	-	-	-	-	-	-	-	-	-
22	0.14	0.02	-	-	-	-	-	-	-	-	-	-	-	-
23	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown	-	-	0.02	-	0.03	0.53	-	0.02	-	-	-	-	--	-
Mean	134.40	73.03	22.44	77.91	36.01	58.36	79.68	207.86	136.73	46.49	96.20	24.90	51.89	31.33
No. Sets	39	47	40	33	56	38	39	22	19	29	36	24	24	28

Table 10. Mean number per tow from R.V. surveys in Subdivision 3Ps. The same strata were used in the calculations for each year. Values for the trips by the A. T. Cameron, 1973-82 were adjusted by the appropriate conversion factors so that these trips would be comparable to those of the A. Needler, 1983-84, and the W. Templeman, 1985-86.

	YEAR-SURVEY													
Age	ATC207 1973	ATC221 1974	ATC234 1975	ATC247 1976	ATC261 1977	ATC275 1978	ATC287 1979	ATC302 1980	ATC316 1981	ATC330 1982	AN9 1983	AN26 1984	WT26 1985	WT 45 1986
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	0.02	0.33	0.01	-	0.01	-	0.08	0.45	0.09	0.05	0.01	-	-	-
3	1.88	2.24	0.52	0.28	0.09	0.67	0.28	2.12	0.99	0.64	0.22	-	-	0.12
4	3.80	4.44	1.35	3.60	0.38	0.73	1.49	2.78	4.38	1.83	0.96	0.11	0.12	0.52
5	8.71	6.06	2.63	5.54	3.28	3.39	3.90	8.35	5.57	2.40	4.40	0.23	0.47	1.13
6	16.46	4.72	3.70	13.11	3.55	5.27	7.40	17.32	11.50	3.19	12.25	1.38	1.09	3.86
7	22.12	6.90	3.70	10.51	7.59	7.67	20.37	52.05	31.42	5.11	17.81	3.31	1.48	5.75
8	17.03	6.71	2.92	11.15	7.63	9.85	17.37	47.85	42.71	8.35	20.05	4.99	1.40	5.53
9	15.80	8.79	0.98	8.70	5.39	10.70	8.73	30.14	24.72	11.07	19.45	5.05	2.17	3.67
10	12.52	6.38	1.01	9.38	3.48	4.81	3.09	17.58	8.39	6.00	9.85	4.61	3.63	2.73
11	8.28	5.57	0.92	6.11	2.25	5.12	2.85	6.61	1.92	2.39	5.84	2.70	5.05	1.84
12	4.00	5.83	0.96	2.48	0.83	3.66	2.71	3.82	1.65	1.99	2.05	1.32	5.16	1.89
13	5.14	4.48	0.48	1.18	0.14	1.72	1.57	1.76	1.90	1.00	1.24	0.53	5.82	1.57
14	3.26	0.84	0.20	0.42	0.31	0.60	1.09	0.66	2.30	0.77	0.68	0.39	5.12	0.92
15	2.81	1.85	0.17	0.38	0.13	0.20	0.85	0.02	0.59	0.29	0.51	0.19	6.38	0.99
16	1.49	0.32	0.22	0.46	0.07	0.57	0.54	0.29	0.91	0.15	0.59	0.05	5.76	0.57
17	0.98	0.55	0.06	0.08	0.02	0.14	0.09	0.02	0.30	0.08	0.14	0.02	3.66	0.16
18	0.79	0.14	0.07	0.12	0.02	-	-	0.03	0.61	0.15	0.09	0.02	4.19	0.07
19	0.32	0.18	0.03	0.03	0.01	-	-	-	0.64	0.03	0.06	-	0.26	0.01
20	0.10	0.04	-	0.04	-	-	-	-	-	0.02	-	-	0.13	-
21	0.24	-	-	-	-	-	-	-	-	-	-	-	-	-
22	0.18	0.03	-	-	-	-	-	-	-	-	-	-	-	-
23	0.06	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown	-	-	0.02	-	0.01	0.58	-	0.02	-	-	-	-	-	-
Mean	125.99(39)	66.40(47)	19.95(40)	73.57(33)	35.19(56)	55.68(38)	72.41(39)	191.87(22)	140.59(19)	45.51(29)	96.20(36)	24.90(24)	51.89(24)	31.33(28)

Table 11. Mean number and weight per 30 minute tow, and corresponding abundance and biomass estimates, of American plaice from research vessel survey data from selected strata in Subdivision 3Ps.

Year	Mean number/tow	Number x 10^{-6}	No. sets	Missing strata	Mean weight kg/tow	Biomass kg x 10^{-6}
1972	26.9	5.1	23	308,310,318	11.6	2.2
1973	137.4	28.6	39	310	46.9	9.8
1974	77.3	17.1	47	-	25.4	5.6
1975	22.7	4.7	40	316	7.1	1.5
1976	77.9	16.2	33	310	25.2	5.3
1977	36.0	8.0	56	-	18.0	4.0
1978	58.2	12.4	38	308	17.2	3.7
1979	79.9	17.7	39	-	25.1	5.6
1980	206.9	45.7	22	-	47.3	10.5
1981	136.8	29.0	19	318	47.8	10.1
1982	46.5	9.6	29	316	17.0	3.5
1983	96.2	21.3	36	-	45.8	10.1
1984	24.9	5.5	24	-	16.4	3.6
1985	51.9	11.0	24	318	101.8	21.6
1986	31.4	6.9	28	-	20.8	4.6
1987	67.2	14.9	31	-	57.6	12.7

Table 12. Partial recruitment vectors for A. plaice in Subdivision 3Ps

Age	PR used in 1981 assessment	PR used in current assessment
6	.01	.002
7	.03	.024
8	.10	.20
9	.28	.49
10	.40	.79
11	.55	1.00
12	.78	1.00
13-19	1.00	1.00

Table 13. Estimates of mortality for A. plaice in Subdivision 3Ps, from commercial and research vessel survey data.

	Catch curves					
Age	Ln, 1986 survey nos/tow, sel. strata		Ln, 1983-86 survey nos/tow, sel. strata		Ln, 1986 commercial numbers at age	
7	1.75		3.34		4.14	
8	1.71		3.46		5.53	
9	1.30		3.41		6.11	
10	1.00		3.04		6.60	
11	0.61		2.74		7.01	
12	0.64		2.34		6.72	
13	0.45		2.21		5.89	
14	-0.08		1.96		5.75	
15	-0.01		2.09		5.09	
16	-0.56		1.94		4.20	
17	-1.83		1.38		3.00	
18	-2.66		1.47		1.95	
19	-4.61		-1.11		-	
20	-		-2.04		-	
r	0.92	Ages	0.88	Ages	0.98	Ages
intercept	5.48	7-19	6.91	8-20	15.26	11-18
Slope	-0.43		-0.37		-0.71	
r	0.94	Ages	0.97	Ages		
intercept	4.59	7-18	5.09	8-18		
Slope	-0.35		-0.21	(Fig. 5)		

Table 13 (Cont'd.)

Survival Estimates, catch numbers per 10 hours of effort

Age	1984	1985	1986	1985/84	1986/85
6	12	8	4	$\frac{\Sigma 10\text{-}19(85)}{\Sigma 9\text{-}18(84)} = \frac{9476}{12{,}578}$, Z=0.28	$\frac{\Sigma 10\text{-}19(86)}{\Sigma 9\text{-}18(85)} = \frac{4962}{12{,}123}$, Z=0.89
7	40	75	89		
8	308	1010	357		
9	1738	2658	637		
10	3317	3243	1045	$\frac{\Sigma 11\text{-}19(85)}{\Sigma 10\text{-}18(84)} = \frac{6233}{10{,}840}$, Z=0.55	$\frac{\Sigma 11\text{-}19(86)}{\Sigma 10\text{-}18(85)} = \frac{3917}{9465}$, Z=0.88
11	3467	2692	1424		
12	1891	1546	1173		
13	1012	775	511		
14	663	515	445	$\frac{\Sigma 12\text{-}19(85)}{\Sigma 11\text{-}18(84)} = \frac{3541}{7523}$, Z= 0.75	$\frac{\Sigma 12\text{-}19(86)}{\Sigma 11\text{-}18(85)} = \frac{2493}{6222}$, Z=0.92
15	317	347	230		
16	121	182	95		
17	35	120	28		
18	17	45	10		
19	3	11	1		

Survival Estimates, R.V. Survey nos/tow (Table 9)

6	1.38	1.09	3.86		
7	3.31	1.48	5.75	$\frac{\Sigma 10\text{-}19(85)}{\Sigma 9\text{-}18(84)} = \frac{45.03}{14.88}$, Z<0.	$\frac{\Sigma 10\text{-}19(86)}{\Sigma 9\text{-}18(85)} = \frac{10.75}{46.94}$, Z=1.47
8	4.99	1.40	5.53		
9	5.05	2.17	3.67		
10	4.61	3.63	2.73		
11	2.70	5.05	1.84		
12	1.32	5.16	1.89		
13	0.53	5.82	1.57		
14	0.39	5.12	0.92		
15	0.19	6.38	0.99		
16	0.05	5.76	0.57		
17	0.02	3.66	0.16		
18	0.02	4.19	0.07		
19	-	0.26	0.01		

Table 14. Results of SPA calibration, 3Ps A. plaice.

Regression	Parameter	FT .15	.18	.184	.20	.30
8+biomass from SPA vs CPUE, 1974-86, 1984-85 omitted	r	.769	.724	.716	.677	.228
	intercept	-7790	-749	+19	+2784	+7132
	'86 residual	+7110	+4716	+4455	+3513	-91

Table 15. Results of SPA on 3Ps A. plaice at F_t = 0.18.

POPULATION NUMBERS

AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
6	15639	14625	12120	14068	17665	20469	17237	25841	23181	15915	11324	11766	19697	9176
7	12887	12804	11679	9369	11408	14447	16714	15632	21155	18732	13023	9267	9627	16124
8	8723	10377	9666	8603	7432	9220	11651	13467	12689	17066	15475	10591	7575	7850
9	7697	6360	7692	7261	6176	5786	7113	9020	10582	9821	13904	12307	8575	5889
10	9148	5339	4176	5715	4575	4347	3885	5002	6713	7864	7877	10871	9531	6120
11	7804	3404	3228	3072	3533	2927	2844	2422	3439	5037	5738	5677	7859	6705
12	5186	2563	2138	2260	1630	2031	1712	1614	1440	2476	3126	4245	3576	5525
13	2566	2045	1378	1307	1204	1024	1006	1086	829	947	1623	2262	2882	2494
14	1525	1110	949	818	654	725	545	620	560	418	602	1077	1535	2097
15	897	645	527	544	468	314	390	311	444	133	233	413	690	1062
16	412	468	360	377	299	181	145	213	182	56	70	177	238	447
17	443	224	204	212	193	32	81	80	129	20	27	46	107	134
18	167	303	64	96	128	16	8	45	45	13	6	20	27	47
19	19	120	124	6	41	13	3	4	24	2	6	4	11	7
6+	74714	60406	54324	54107	55427	61531	65114	75359	81417	78700	72761	68763	71931	63602
7+	59275	45781	42204	40040	37761	41062	48877	47318	58236	62785	61437	56997	52234	54406
8+	46588	32977	30526	30471	26353	26615	29163	33886	37080	43853	48409	47730	42604	38282
9+	37865	22600	20860	21868	18921	17395	17512	20418	24391	26787	32934	37139	35030	30424
10+	28168	16240	13168	14407	12725	11609	10400	11399	13809	16966	19127	24832	26455	24564
11+	19020	10901	8992	8692	8150	7263	6535	6397	7972	9102	11430	13760	16924	18444
12+	11215	7498	5764	5620	4617	4336	3691	3975	3533	4065	5692	8263	9065	11740
13+	6029	4915	3626	3359	2987	2305	2179	2360	2212	1589	2566	4016	5489	6217

POPULATION BIOMASS

AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
6	4125	3811	3132	3607	4225	5762	6338	3771	7324	4370	2933	2964	3642	2425
7	3345	4018	4069	2976	3257	4186	6735	4684	8605	7267	4884	2543	2377	5226
8	2745	3872	4022	3259	2281	3151	4872	4867	5633	6443	6348	3407	2372	3136
9	3513	2798	3877	3175	2267	2338	3507	3836	4587	3705	6852	4972	3523	2634
10	3788	2971	2844	2963	2387	1967	2350	2362	3765	3460	4466	4761	5199	3623
11	4141	2417	2403	1886	2108	1644	2141	1487	2284	2628	3537	2906	3854	4752
12	3993	2218	2133	1736	1366	1424	1836	1148	1221	1866	2286	2960	3583	5353
13	2517	2033	1530	1208	1329	670	1423	1078	877	792	1273	2014	3762	2730
14	1660	1446	1218	955	746	669	876	1099	474	487	756	1154	2470	3282
15	1470	1009	721	710	555	387	699	505	368	173	372	561	1312	2070
16	815	631	671	561	247	308	327	424	192	94	138	337	475	1059
17	1142	332	385	406	169	47	196	181	135	32	66	93	234	397
18	457	649	75	195	137	22	17	107	47	30	18	45	50	150
19	56	299	265	16	52	30	8	10	38	6	23	10	27	29
6+	33986	28744	26089	23653	21129	23012	31366	25377	35590	31703	33975	28347	34929	37303
7+	29861	24933	24737	20045	16905	17250	25008	21608	28266	27333	31040	25383	31287	34878
8+	26517	20915	20668	17069	13648	13064	18273	16924	19661	20066	26157	22840	28908	29613
9+	23772	17023	16345	13810	11366	9713	13401	12257	14008	13603	19808	19432	26517	26477
10+	20259	14225	12446	10635	9097	7576	9894	8421	9421	9657	12956	14660	22994	23647
11+	16471	11234	9601	7672	6710	5606	7544	6037	5656	6237	8489	10079	17795	20024
12+	12330	8817	7198	5786	4601	3762	5403	4552	3373	3609	4952	7173	11941	15272
13+	8337	6599	5066	4030	3235	2336	3566	3405	2152	1743	2666	4213	8358	9719

FISHING MORTALITY

AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
6	0.000	0.025	0.036	0.010	0.001	0.003	0.007	0.000	0.002	0.000	0.000	0.000	0.000	0.000
7	0.001	0.081	0.093	0.053	0.013	0.015	0.016	0.009	0.015	0.002	0.007	0.002	0.003	0.004
8	0.116	0.099	0.086	0.151	0.050	0.060	0.056	0.041	0.056	0.012	0.027	0.011	0.057	0.036
9	0.397	0.221	0.077	0.262	0.155	0.203	0.152	0.075	0.097	0.043	0.039	0.056	0.137	0.080
10	0.789	0.303	0.107	0.281	0.247	0.297	0.287	0.175	0.088	0.115	0.101	0.124	0.152	0.142
11	0.906	0.265	0.156	0.434	0.354	0.336	0.273	0.320	0.128	0.277	0.101	0.266	0.153	0.180
12	0.731	0.414	0.272	0.430	0.265	0.503	0.255	0.467	0.220	0.223	0.123	0.187	0.177	0.180
13	0.638	0.567	0.336	0.493	0.307	0.430	0.284	0.463	0.465	0.252	0.192	0.186	0.118	0.180
14	0.661	0.545	0.357	0.339	0.535	0.420	0.360	0.135	1.240	0.386	0.178	0.264	0.150	0.180
15	0.450	0.384	0.137	0.399	0.748	0.568	0.403	0.339	1.662	0.444	0.074	0.347	0.233	0.180
16	0.409	0.630	0.328	0.466	2.036	0.611	0.396	0.300	1.772	0.530	0.211	0.304	0.379	0.180
17	0.180	1.053	0.558	0.302	2.276	1.177	0.377	0.361	2.115	1.059	0.130	0.337	0.627	0.180
18	0.134	0.674	2.130	0.641	2.104	1.376	0.532	0.419	2.757	0.566	0.213	0.415	1.175	0.180
19	0.258	0.731	0.473	0.434	2.120	0.714	0.394	0.334	2.108	0.634	0.205	0.339	0.534	0.180

Table 16. Parameters used in catch projections for A. plaice in Subdiv. 3Ps.

Age	1987 Beginning Year Population ('000)	Av. wts. (kg) 1984-86	Partial Recruitment
6	17,010	.258	.002
7	13,924	.312	.018
8	10,530	.388	.14
9	6,206	.487	.36
10	4,392	.620	.65
11	4,347	.791	1.00
12	4,585	1.073	1.00
13	3,777	1.355	1.00
14	1,644	1.697	1.00
15	1,434	2.148	1.00
16	740	2.669	1.00
17	306	3.135	1.00
18	91	3.478	1.00
19	32	4.056	1.00

Table 17. Catch projections, 3Ps A. plaice.

POPULATION NUMBERS

AGE	1986	1987	1988
6	17010	17010	17010
7	12931	13924	13920
8	7858	10530	11352
9	5857	6205	8348
10	6120	4372	4673
11	6705	4347	3071
12	5023	4585	2820
13	2404	3777	2974
14	2057	1644	2450
15	1082	1434	1066
16	447	740	930
17	134	306	480
18	47	91	198
19	7	32	59
6+	68223	69018	69369
7+	51213	52008	52359
8+	38282	38084	38439
9+	30424	27554	27987

CATCH NUMBERS

AGE	1986	1987	1988
6	3	7	8
7	63	33	37
8	252	306	354
9	449	433	632
10	737	560	637
11	1004	621	622
12	827	866	568
13	360	714	377
14	314	311	473
15	162	271	215
16	67	140	187
17	20	58	97
18	7	17	40
19	1	6	12
6+	4266	4583	4540
7+	4263	4576	4532
8+	4200	4523	4495
9+	3948	4217	4121

FISHING MORTALITY

AGE	1986	1987	1988
6	0.000	0.000	0.000
7	0.005	0.004	0.004
8	0.036	0.033	0.035
9	0.088	0.084	0.070
10	0.142	0.151	0.162
11	0.160	0.233	0.250
12	0.160	0.233	0.250
13	0.160	0.233	0.250
14	0.160	0.233	0.250
15	0.160	0.233	0.250
16	0.160	0.233	0.250
17	0.160	0.233	0.250
18	0.160	0.233	0.250
19	0.160	0.233	0.250

POPULATION BIOMASS (AVERAGE)

AGE	1986	1987	1988
6	3972.96	3971.54	3971.47
7	3851.02	3933.64	3931.98
8	2713.67	3642.19	3922.02
9	2479.17	2631.49	3527.74
10	3215.97	2297.54	2431.49
11	4413.88	2791.94	1969.79
12	4931.37	3994.60	2487.01
13	2709.33	4102.82	3244.50
14	2760.32	2264.59	3347.88
15	1933.20	2500.17	1844.67
16	993.34	1602.56	1998.97
17	348.37	778.69	1211.66
18	135.27	257.87	555.94
19	22.54	105.25	193.53
6+	34476.62	34924.89	34388.65
7+	30504.56	30953.35	30417.18
8+	26655.55	27019.71	26485.20
9+	24141.88	23377.52	22763.18

CATCH BIOMASS

AGE	1986	1987	1988
6	1	2	2
7	20	16	18
8	78	119	137
9	219	221	317
10	437	348	395
11	794	530	472
12	888	930	607
13	488	967	811
14	533	527	837
15	348	582	461
16	179	373	500
17	63	181	303
18	24	60	139
19	4	25	48
6+	4115	5000	5071
7+	4114	4998	5069
8+	4094	4982	5051
9+	3996	4863	4914

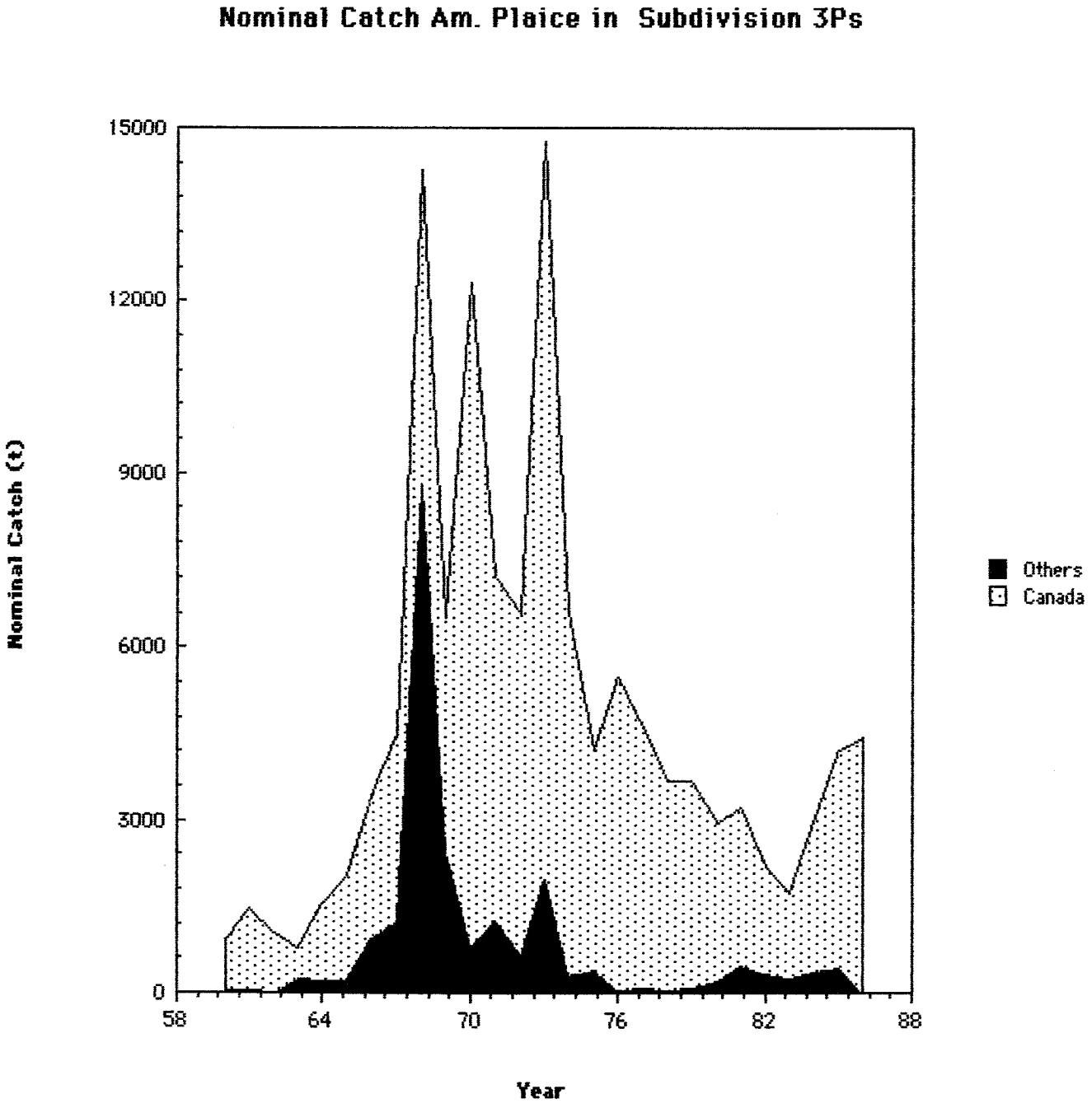

Fig.1. Nominal catch of Amercian plaice in subdivision 3Ps from 1960-1986.

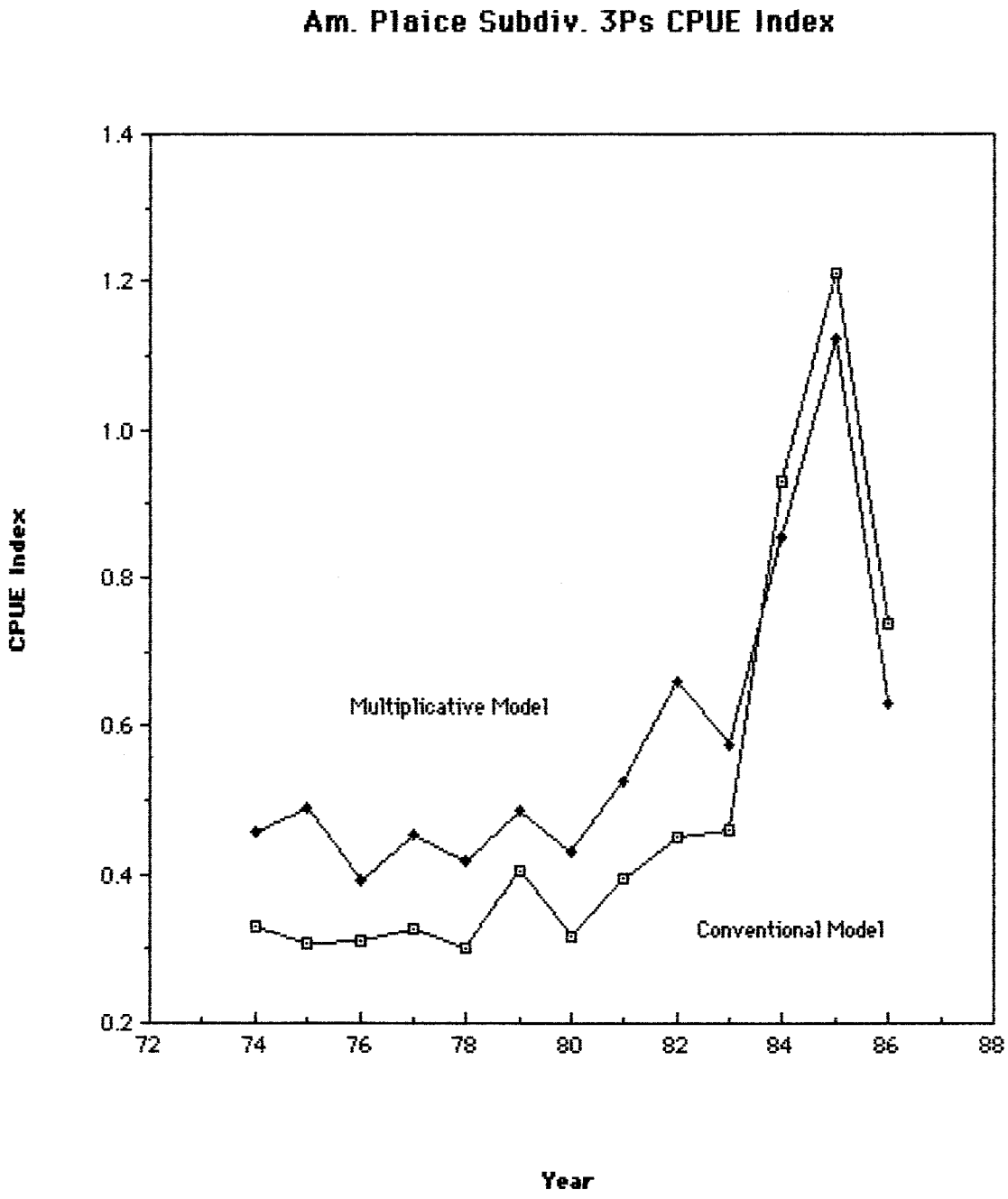

Fig.2. CPUE index of American plaice in NAFO Subdivision 3Ps during 1974-1986 using the conventional model and the multiplicative model.

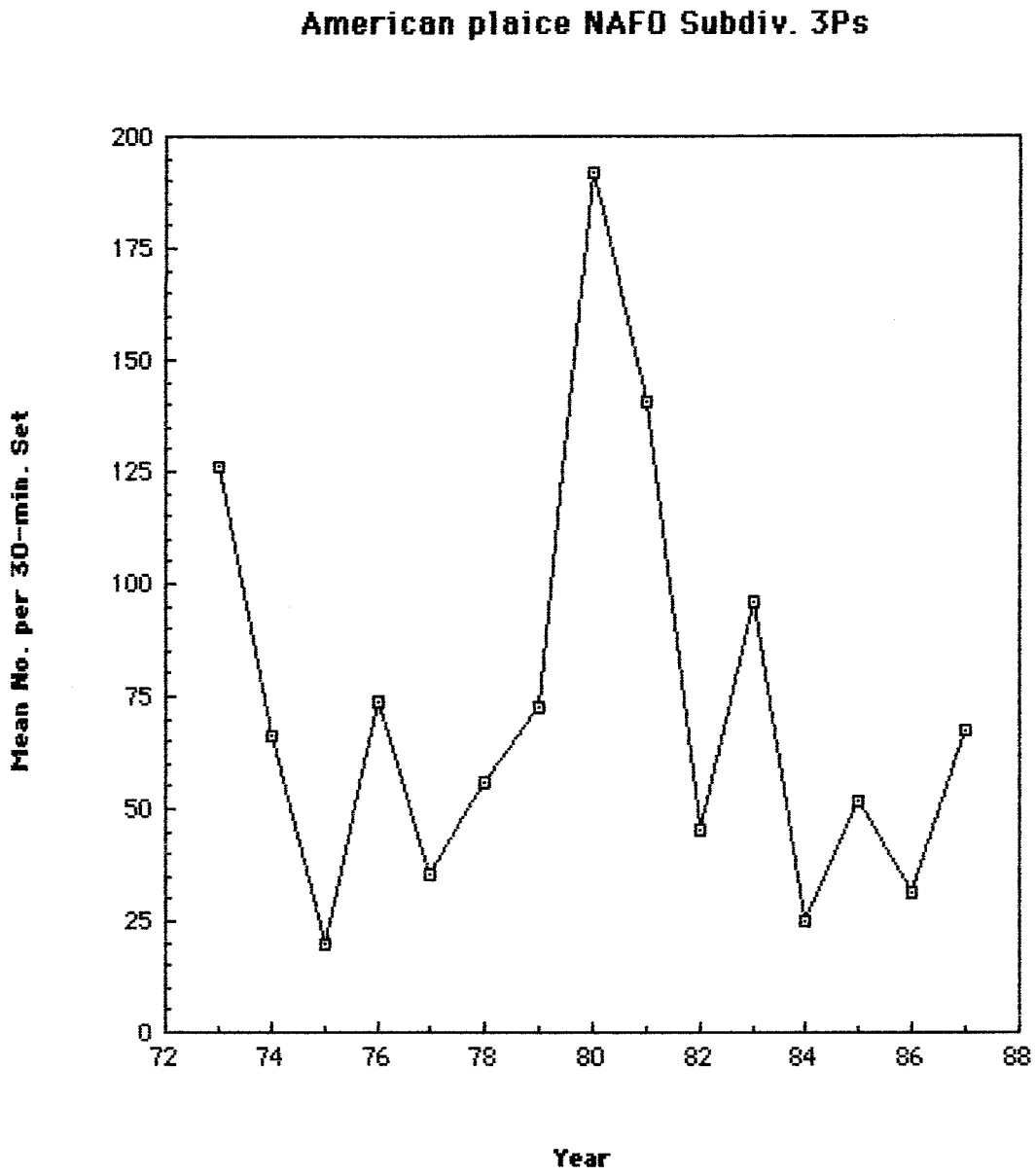

Fig.3. Mean no. per set of American plaice from research vessel surveys in NAFO subdiv. 3Ps during 1973-1987.

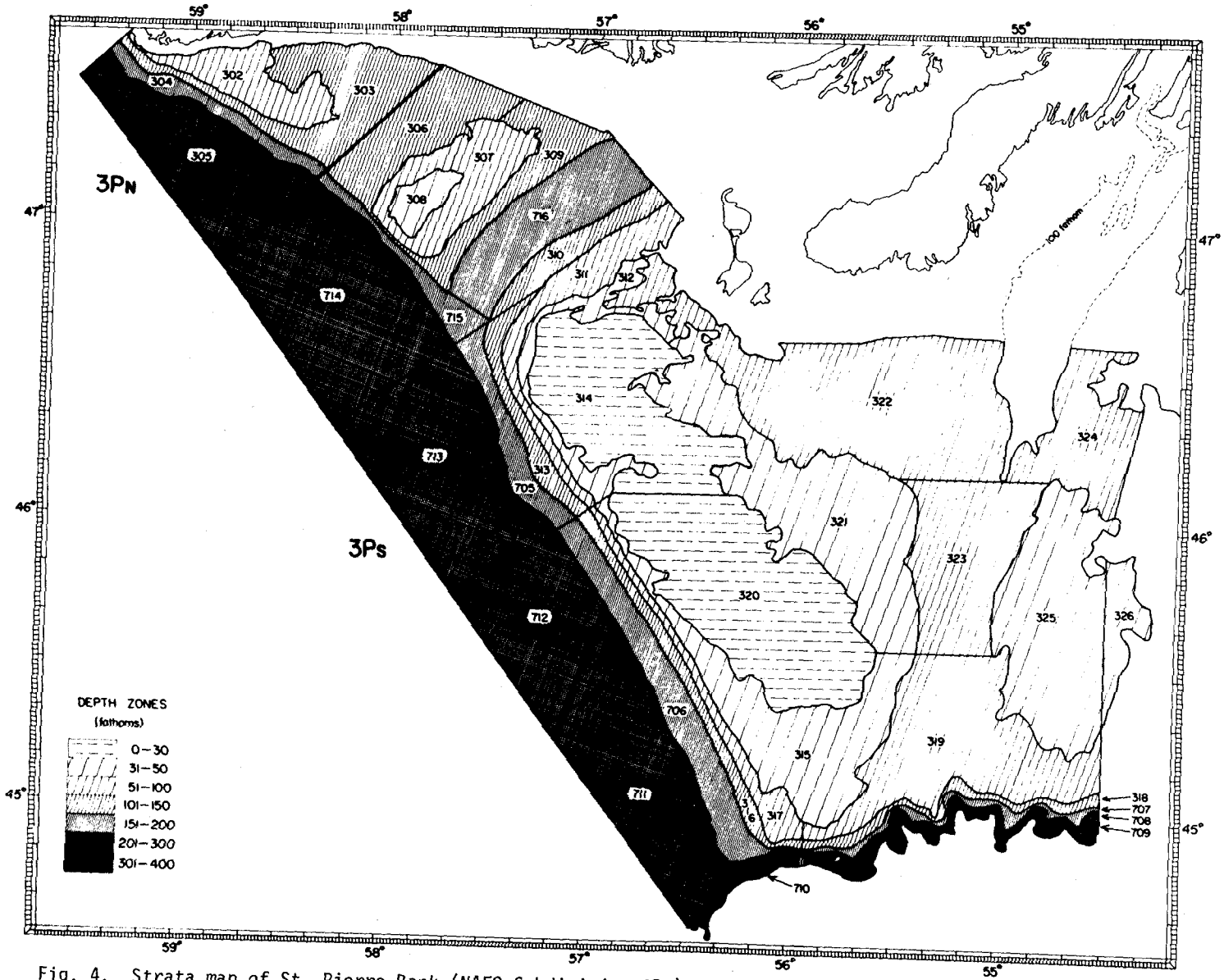

Fig. 4. Strata map of St. Pierre Bank (NAFO Subdivision 3Ps)

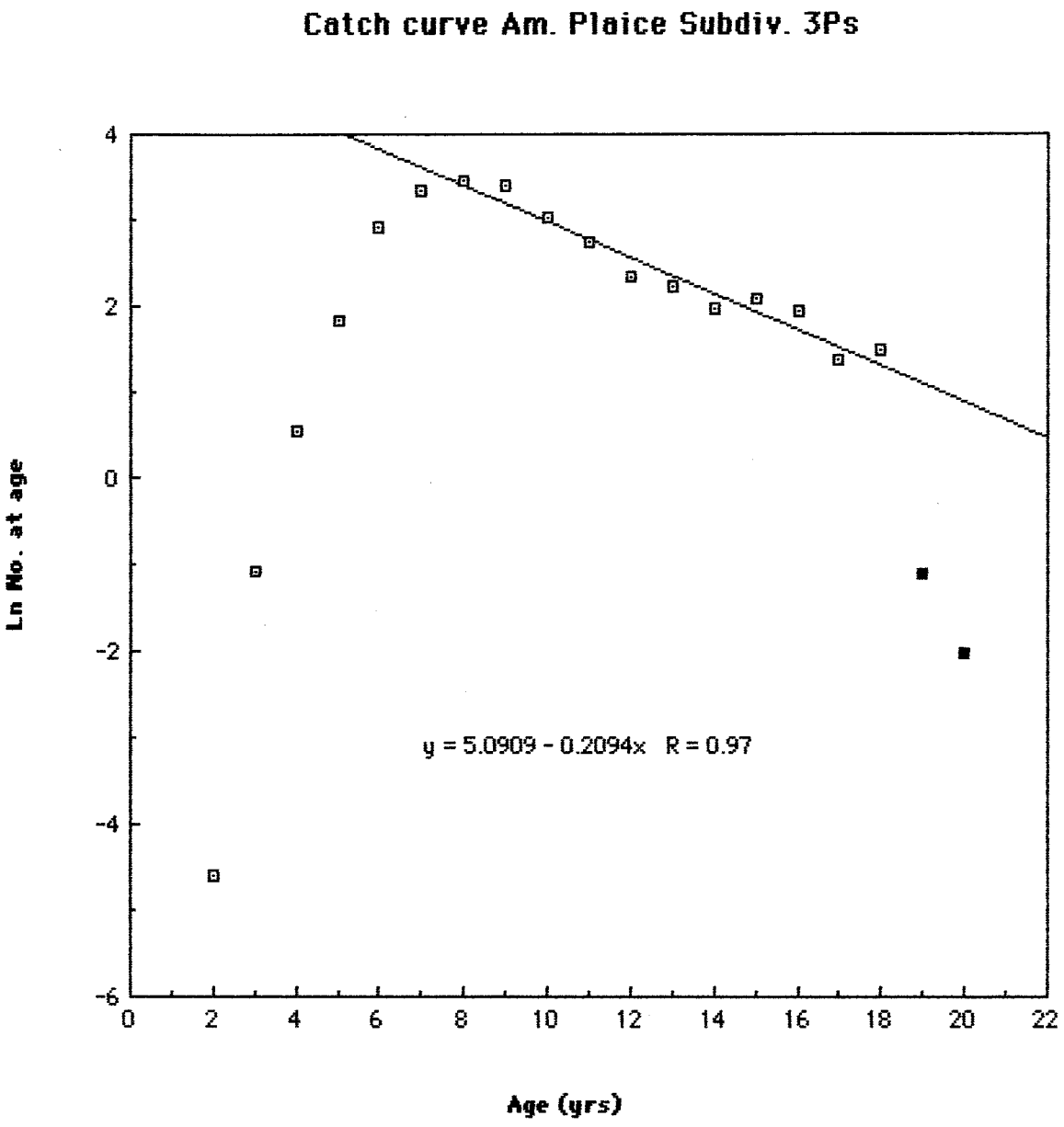

Fig.5. Catch curve of American plaice from research vessel surveys in NAFO Subdivision 3Ps, 1983-86.

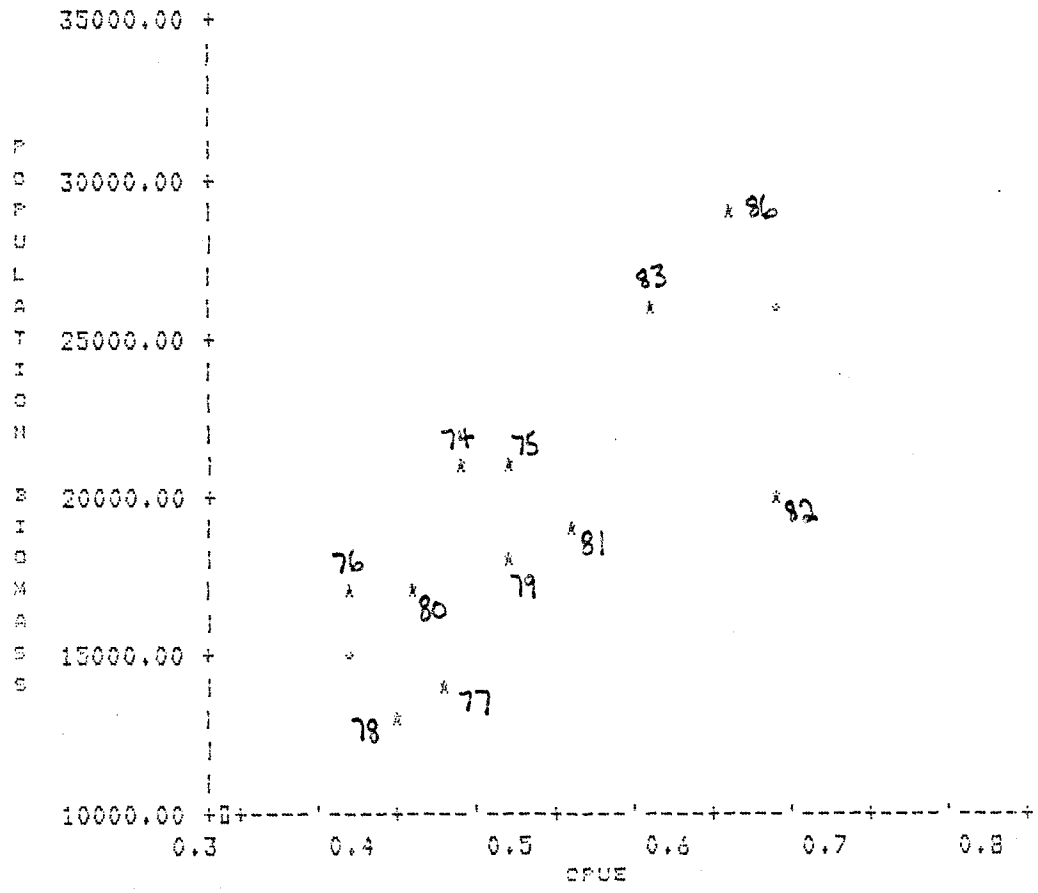

Fig. 6. Plot of 8+ Biomass from SPA at F_t = 0.18 vs CPUE, 3Ps A. plaice.