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Stock Assessment Update of American Plaice in NAFO Subarea 2 - Division 3K

by

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Abstract

A virtual population analysis was attempted using data from 1975 to 1981. There was a considerable difference in the total mortality rates calculated from commercial and research data and terminal F was difficult to estimate because of the shortness of the data series. Catch rates by the commercial fleet increased substantially in 1981 over 1980 and research vessel surveys indicated an increase in abundance over the period 1979-81. In spite of problems in arriving at a precise value for terminal F in 1981, the assessment indicated that the stock appears to be in good condition.

Résumé

Nous avons tenté une analyse de population virtuelle fondée sur les données recueillies entre 1975 et 1981. Les taux de mortalité totale calculés d'après les données des bateaux de pêche commerciaux diffèrent beaucoup de ceux des navires de recherche, et il a été difficile d'estimer le F de dernière année à cause de la brièveté de la série de données. Les taux de capture de la flottille commerciale augmentèrent de façon substantielle en 1981 par rapport à 1980, et les relevés par navires de recherches indiquent un accroissement des effectifs pendant la période de 1979-81. En dépit de la difficulté à obtenir une valeur précise de F de dernière année en 1981, l'évaluation indique que le stock semble être en bonne condition.

Introduction

This stock has been under quota regulations since 1974. TAC's since then are listed below (t X 10^{-3}):

1974	1975	1976	1977	1978	1979	1980	1981	1982
10.0	8.0	8.0	8.0	6.0	6.0	6.0	6.0	10.0

As seen in Table 1, the highest recorded nominal catch was 12,686 t in 1970, owing mainly to the high catch by the USSR. However, this figure and all other pre-1973 values must be questioned because plaice landings were reported as "unspecified flatfish" and only later was this category broken down into species.

The reduction in the TAC in 1978 from 8000 to 6000 t was based on average catches in 1974-75 that indicated F was close to the F0.1 level of approximately 0.3. The raising of the TAC in 1982 to 10,000 t was based on the increase of CPUE over 1978-81 to a high of 0.970 t/hr (Table 2), which suggested an increase in abundance of the stock (Pitt and Brodie 1981).

Up to 1976, most of the Canadian landings were by inshore gears and samples from this segment of the fishery were not representative of the total catch, most of which was being taken by the offshore foreign fleet. In 1977 there was a significant directed fishery by Canadian trawlers but this was reduced in 1978 and 1979. This fishery picked up again in 1980 and the offshore segment was closed when the trawler allocation of 3000 t was exceeded. The TAC was exceeded by the trawler component alone in 1981, with some 5200 t having been landed in the first 3 mo. Catch rates in 1981 were exceptional and were up 85% over 1980 levels.

Stock assessment

Numbers at age were available from 1976-81 (Table 4). The sampling in 1978-81 was considered adequate while the sampling level in 1976-77 was lower. Table 3 gives a summary of the 1981 samples. The numbers at age were calculated in the usual manner by applying quarterly age-length keys (sexes separate) to monthly frequencies for each NAFO Division. Males and females were then summed to give total numbers at age.

Weights-at-age were calculated by applying a length-weight relationship to monthly length frequencies which were weighted by numbers caught. The weights-at-age are in Table 5.

Partial recruitment (PR) for 1981 (Table 6)was derived from average F's in a preliminary cohort run using the 1977-80 catch number matrix. Values for PR at ages 7-9 were adjusted, based on the ratio of commercial numbers/1000 to research numbers/1000, to compensate for what was considered to be very high discard rates in these age groups (Fig. 1).

Yield per recruit (Table 8) was evaluated using average weights, 1976-81 (Table 7) and average partial recruitment from a cohort run using the 1977-80 catch-at-age matrix (Table 7). M was assumed to be 0.20 and $F_{0.1}$ was calculated as 0.318, which showed little difference from the value of 0.307 used in last year's assessment (Pitt and Brodie 1981).

Research vessel survey population estimates for 1978-81 for NAFO Divisions 2J and 3K are given in Tables 9 and 10. Biomass estimates from the same surveys are given in Table 11.

Total mortality estimated from survival rates from commercial catch-at-age per hour data indicated negative values for $\bar{z}$ (Table 13). Survival rates from research vessel data (Table 12) show that $\bar{z}$ is in the range of 0.7 over the fully recruited ages. A catch curve (Fig. 2) using percent caught at age for 1977-81 gave a $\bar{z}$ value of 0.542 for ages 12-18.

Terminal F (F_T) was difficult to estimate due to the short series of data. Although a regression of biomass from VPA on CPUE did produce an r^2 value of approximately 0.85, the relationship was hardly affected by large changes in F_T (Table 16, Fig. 3). The relationship was of no use in predicting where the 1981 point should lie on the line. Much the same difficulties were encountered when using a regression of F on effort (Table 17, Fig. 4).

Virtual Population Analysis (VPA) are presented in Tables 14 and 15. Because of uncertainties in determining F_T, the runs at $F_T = 0.3$ and $F_T = 0.35$ were chosen using the PR in Table 6.

Recruitment was estimated as the geometric mean (GM) of age 7 VPA numbers, 1977-80, for projections to 1983. Because of some uncertainty, due to discarding, the GM was also used as the best estimate of the VPA population at age 7 in 1981.

Stock projections to 1983 using a population in 1981 generated by $F_T = 0.30$ are shown in Table 18. The values of PR and weight-at-age used in projecting the 1982 and 1983 removals at age are the long-term averages (Table 7). Assuming that the 1982 TAC of 10,000 t will be taken and that the average PR and weights will apply, the projected level of removals for 1983 at $F_{0.1}$ is 11,900 t.

Discussion

Total mortality calculated from catch curves in 1974 (Pitt 1974) indicated mortality in the 1962-71 period was in the range of 0.5. Calculations from the catch curve in Fig. 2 show $\bar{z}$ in the range of 0.55. Survival rates indicating negative $\bar{z}$'s in the commercial data were of no use in determining Terminal F and the research data show $\bar{z}$ in the fully recruited ages to be approximately 0.7.

The increase in catch rate since 1978 (although the 1978 and 1979 figures are based on very small catches) may indicate that the stock size is increasing. Research vessel estimates of biomass in NAFO Div. 2J and 3K also show increased abundance over the period 1979-81 (Tables 9-11). Attempts to tune the VPA

using biomass from VPA on CPUE were not successful, despite high values for r^2 (Table 16), due to the short series of data.

Because of changes in the offshore allocation of the 2J3KL cod stock, the concentrated fishery which occurred in this area in the first 3 months of 1981 did not occur in the same period in 1982. Catches of American plaice in 2J-3K in Janaury-March 1981 approached 5000 t whereas the figure will probably be closer to 1000 t for the same period in 1982. Thus, a major change in the fishing pattern will again be observed for this stock in 1982.

Discarding was felt to be a major area of concern in the trawler fishery in 1981 and this is reflected in the very low values for ages 7-9 in the catch-at-age for 1981. Although no estimates of discarding were available, Fig. 1 indicates fewer small fish in the 1981 landings compared to 1980. There is no evidence from the research vessel surveys (Table 9) to indicate that there were proportionately fewer small fish in the population in 1981.

The decline in average weights in 1981 can be explained by the high proportion of the total catch taken by the offshore fleet in the first 3 months of the year. In earlier years, particularly 1978 and 1979, the inshore fleet took a larger share of the catch with gillnets. Thus, the majority of the catch was taken later in the year with a gear which selected larger fish. Because of the decline of the January-March otter trawl fishery in 1982, catch projections were made with the long-term average weights-at-age (Table 7).

Virtual population runs were made, using various terminal F's and attempts to fine-tune the analysis using standard methods were not successful. VPA runs at F_T = .3 and .35 are presented and the resulting population from the VPA run at F_T = .3 was projected to 1983. Results of these analyses appear in Tables 14-18.

References

Pitt, T. K. 1974. Assessment of American plaice from Subarea 2 + Division 3K. ICNAF Res. Doc. 74/69. Serial No. 3299.

Pitt, T. K., and W. B. Brodie. 1981. Stock assessment of American plaice in NAFO Subarea 2 - Division 3K. CAFSAC Res. Doc. 81/51.

Table 1. Nominal catches (t), American plaice, NAFO Subarea 2 and Division 3K, 1967-81.

Year	Canada Inshore	Canada offshore	Canada Total	Poland	USSR	Other	Total
1967	395		395	1,134	1,701	414	3,644
1968	1,023		1,023	1,889	2,911	128	5,951
1969	1,689		1,689	867	4,129	217	6,902
1970	3,751		3,751	378	8,160	397	12,686
1971	2,486		2,486	233	2,597	32	5,348
1972	1,188	9	1,197	849	6,760	317	9,123
1973	1,368	16	1,384	225	3,011	520	5,140
1974	462	106	568	91	4,643	308	5,610
1975	813	46	859	95	4,449	345	5,748
1976	1,741	736	2,477	118	3,373	131	6,099
1977	1,925	4,691	6,616	27	702	162	7,507
1978	1,723	1,452	3,175	138	123	86	3,522
1979	1,792	1,063	2,855	31	39	53	2,978
1980	1,149	3,728	4,877	39	26	91	5,033
1981[a]	1,012	6,282	7,294				7,294

[a]Provisional.

Table 2. Catch and effort, American plaice, Subarea 2 and Division 3K.

Year	Total catch (t)	Directed CPUE (t/hr)	Effort (hr)	Directed catch (t)
1976	6,099	(0.395)	15,440	701
1977	7,507	0.402	18,674	3,628
1978	3,522	0.375	9,392	652
1979	2,978	0.467	6,377	315
1980	5,033	0.525	9,587	2,151
1981[a]	7,294	0.970	7,519	5,124

[a]Preliminary.

Table 3. List of commercial American plaice samples from Divisions 2J and 3K, 1981.

Quarter	Number measured 2J	Number measured 3K	Number otoliths 2J	Number otoliths 3K	Number samples 2J	Number samples 3K	
1	542	6328	136	659	2	16	(offshore)
2	-	2675	-	365	-	6	(offshore)
3	-	1856	-	372	-	4	(inshore)
4	-	2516	-	512	-	5	(inshore)

Table 4. Catch-at-age matrix (Numbers X 10^{-3}) for American plaice NAFO Subarea 2 + Division 3K, 1976-81.

Age	1976	1977	1978	1979	1980	1981
7	1544	403	132	201	83	1
8	1861	1026	277	858	231	23
9	1317	1481	500	1791	772	121
10	1492	1657	830	1467	2158	456
11	1322	1430	1153	901	1751	1449
12	1240	1435	1134	389	1682	3070
13	964	911	974	219	1097	2665
14	259	677	474	92	502	1452
15	138	430	259	21	253	934
16	54	349	186	6	173	700
17	39	140	65	10	46	245
18	27	84	57	1	33	154
19	13	17	9	1	8	25

Table 5. Weight-at-age matrix (kg) for American plaice in NAFO Subarea 2 + Division 3K, 1976-81.

Age	1976	1977	1978	1979	1980	1981
7	0.293	0.293	0.226	0.268	0.351	0.241
8	0.336	0.336	0.272	0.297	0.333	0.258
9	0.423	0.423	0.317	0.374	0.372	0.289
10	0.511	0.511	0.392	0.484	0.373	0.344
11	0.619	0.619	0.514	0.647	0.456	0.375
12	0.756	0.756	0.580	0.882	0.576	0.468
13	0.939	0.939	0.778	1.189	0.790	0.588
14	1.239	1.239	1.011	1.381	0.935	0.780
15	1.402	1.402	1.205	1.959	1.163	1.071
16	1.643	1.643	1.371	1.960	1.278	1.348
17	1.852	1.852	1.639	1.815	1.730	1.623
18	2.088	2.088	1.690	1.960	2.055	1.955
19	2.364	2.364	2.184	2.000	2.347	2.605

Table 6. Partial recruitment values for 1981 for American plaice in NAFO Subarea 2 + Division 3K.

Age	PR
7	0.0003
8	0.0065
9	0.0300
10	0.0800
11	0.2500
12	0.4300
13	0.7000
14	1.0000
15	1.0000
16	1.0000
17	1.0000
18	1.0000
19	1.0000

Table 7. Parameters used in Y/R analysis for American plaice in NAFO Subarea 2 + Division 3K.

AGE	WEIGHT-AT-AGE (kg)	PARTIAL RECRUITMENT
6	0.256	0.010
7	0.279	0.020
8	0.305	0.030
9	0.366	0.060
10	0.436	0.120
11	0.538	0.250
12	0.670	0.430
13	0.871	0.700
14	1.098	1.000
15	1.367	1.000
16	1.541	1.000
17	1.752	1.000
18	1.973	1.000
19	2.311	1.000

NATURAL MORTALITY RATE : 0.2

F0.1 COMPUTED AS 0.3176 AT Y/R OF 0.1727

FMAX COMPUTED AS 0.8038 AT Y/R OF 0.1902

Table 8. Yield per recruit analysis for American plaice in NAFO Subarea 2 + Division 3K.

	FISHING MORTALITY	CATCH (NUMBER)	YIELD (KG)	AVG. WEIGHT (KG)	YIELD PER UNIT EFFORT
	0.1000	0.093	0.099	1.069	1.819
	0.2000	0.150	0.147	0.977	1.350
	0.3000	0.189	0.170	0.899	1.043
F0.1---	0.3176	0.195	0.173	0.887	1.000
	0.4000	0.217	0.181	0.835	0.834
	0.5000	0.239	0.187	0.782	0.686
	0.6000	0.256	0.189	0.738	0.579
	0.7000	0.271	0.190	0.701	0.499
	0.8000	0.284	0.190	0.671	0.437
FMAX---	0.8038	0.284	0.190	0.670	0.435
	0.9000	0.295	0.190	0.645	0.388
	1.0000	0.305	0.190	0.622	0.349
	1.1000	0.314	0.189	0.603	0.317
	1.2000	0.323	0.189	0.586	0.290
	1.3000	0.331	0.189	0.571	0.267
	1.4000	0.338	0.188	0.557	0.248
	1.5000	0.345	0.188	0.545	0.231

Table 9. American plaice numbers at age from research vessel surveys in NAFO Divisions 2J+3K.

Age	Numbers X10-3			
	1978	1979	1980	1981
3				306
4	4,144	1,405	172	1,393
5	21,462	8,775	2,082	6,084
6	35,365	20,916	4,430	30,275
7	38,916	34,638	33,563	50,135
8	31,469	23,966	28,371	48,430
9	30,113	16,183	16,073	22,527
10	17,794	9,703	11,946	19,735
11	9,138	4,003	9,418	6,505
12	9,694	7,385	6,922	6,255
13	7,540	3,209	3,501	2,574
14	3,457	1,233	1,413	1,047
15	3,472	328	539	640
16	1,377	151	204	447
17	351	-	211	-
18	131	-	-	64
7+	153,452	100,799	112,161	158,359

Table 10. Population size (with upper and lower 95% confidence limits) for American plaice 4 years and older from fall research vessel surveys.

Year	Division 2J (Upper)	Division 2J Mean	Division 2J (Lower)	Division 3K (Upper)	Division 3K Mean	Division 3K (Lower)
			Numbers x 10^{-6}			
1977	(153.3)	178.4	(103.5)	-	-	-
1978	(148.8)	110.2	(72.1)	(142.7)	105.8	(69.0)
1979	(89.2)	80.2	(71.2)	(64.4)	51.9	(39.4)
1980	(116.4)	89.1	(61.8)	(76.3)	59.3	(42.2)
1981	(160.6)	118.6	(76.6)	(96.6)	77.6	(58.7)

Table 11. Biomass estimates for American plaice from random stratified surveys in NAFO Divisions 2J and 3K 1978-81. The same strata were used for each year.

Division	1978	1979	1980	1981
		Tons X 10^{-3}		
2J	56,882	36,788	55,974	63,101
3K	57,314	31,354	32,480	37,807
Total	114,196	68,142	88,454	100,908

Table 12. Calculation of survival rates from population estimates from random stratified surveys Divisions 2J and 3K, November-December, 1980 and 1981 using the same strata for each year.

Age	Numbers x 10^{-3} 1980	1981	
4	172	1,393	Σ9-18 (1981) 59,794
5	2,082	6,084	Σ8-17 (1980) 78,598
6	4,430	30,275	S=0.761
7	33,563	50,135	Z=0.273
8	28,371	48,430	
9	16,073	22,527	
10	11,946	19,735	Σ10-18 (1981) 37,267
11	9,418	6,505	Σ9-17 (1980) 50,227
12	6,922	6,255	S=0.743
13	3,501	2,574	Z=0.298
14	1,413	1,047	
15	539	640-	Σ11-18 (1981) 17,532
16	204	447	Σ10-17 (1980) 34,154
17	211		S=0.513
18		64	Z=0.667
			Σ12-18 (1981) 11,027
			Σ11-17 (1980) 22,208
			S=0.497
			Z=0.700

Table 13. Calculation of survival rate from commercial catch/hour data, 1980-81, Divisions 2J+3K. Effort calculated from CPUE Canada(N) OT-5.

Age	1980 Number/100 hr	1981 Number/100 hr	
6	105	13	
7	872	13	Σ8-19 (1981) = 150,206
8	2,428	306	Σ7-18 (1980) = 92,292
9	8,114	1,609	S = 1.628
10	22,682	6,065	Z = -0.487
11	18,404	19,271	
12	17,679	40,830	Σ12-18 (1981) = 122,623
13	11,530	35,444	Σ11-17 (1980) = 57,849
14	5,276	19,311	S = 2.120
15	2,659	12,422	Z = -0.751
16	1,818	9,310	
17	483	3,258	
18	347	2,048	
19	84	332	

Table 14. Virtual population analysis for American plaice in Subarea 2 + Division 3K, 1976-81 using $F_T = 0.3$.

Pop. nos. x 10^{-3}

POPULATION NUMBERS

AGE	1976	1977	1978	1979	1980	1981
7	87066	57276	41214	22759	16001	12260
8	53396	69890	46529	33624	18452	13026
9	25763	42037	56294	37845	26754	14898
10	17853	19905	33080	45638	29368	21207
11	13848	13272	14802	26334	36041	22098
12	6650	10146	9577	11079	20747	27928
13	4289	4328	7014	6819	8719	15469
14	1550	2645	2724	4865	5385	6150
15	863	1036	1557	1804	3900	3956
16	440	582	464	1042	1458	2965
17	194	312	167	213	847	1038
18	75	124	130	78	166	652
19	65	37	27	56	63	106
7+	212053	221589	213580	192155	167903	141754
8+	124986	164313	172366	169397	151901	129494
9+	71591	94423	125837	135773	133450	116468
10+	45827	52386	69543	97928	106696	101570
11+	27974	32482	36463	52290	77327	80363
12+	14126	19210	21661	25956	41286	58265
13+	7476	9064	12084	14877	20539	30337
14+	3187	4736	5070	8058	11820	14868

Biomass in t

POPULATION BIOMASS (MID-YEAR)

AGE	1976	1977	1978	1979	1980	1981
7	22902	15153	8428	5502	5076	2678
8	15957	21117	11434	8927	5532	3043
9	9606	15812	16097	12502	8881	3885
10	7895	8803	11595	19675	9534	6536
11	7367	7009	6605	15159	14506	7245
12	4087	6414	4710	8690	10356	11138
13	3193	3253	4570	7222	5815	7462
14	1581	2544	2257	6028	4333	3775
15	1000	998	1545	3183	3967	3334
16	612	546	442	1845	1580	3145
17	290	385	192	342	1290	1325
18	112	133	148	138	274	1004
19	123	57	44	100	125	217
7+	74724	82225	68067	89313	71270	54788
8+	51822	67072	59640	83811	66193	52110
9+	35865	45956	48205	74884	60662	49067
10+	26260	30144	32108	62382	51781	45182
11+	18365	21341	20513	42707	42246	38646
12+	10998	14331	13908	27548	27740	31401
13+	6911	7917	9198	18858	17384	20263
14+	3717	4664	4628	11636	11569	12801

FISHING MORTALITY

AGE	1976	1977	1978	1979	1980	1981
7	0.020	0.008	0.004	0.010	0.006	0.000
8	0.039	0.016	0.007	0.029	0.014	0.002
9	0.058	0.040	0.010	0.054	0.032	0.009
10	0.097	0.096	0.028	0.036	0.084	0.024
11	0.111	0.126	0.090	0.038	0.055	0.075
12	0.229	0.169	0.140	0.039	0.094	0.129
13	0.283	0.263	0.166	0.036	0.149	0.210
14	0.203	0.330	0.212	0.021	0.108	0.300
15	0.193	0.604	0.202	0.013	0.074	0.300
16	0.145	1.050	0.577	0.006	0.140	0.300
17	0.249	0.673	0.556	0.053	0.062	0.300
18	0.505	1.317	0.649	0.014	0.247	0.300
19	0.250	0.700	0.450	0.020	0.150	0.300

Table 15. Virtual population analysis for American plaice in Subarea 2 + Division 3K, 1976-81, using F_T = 0.35.

Pop. nos. x 10^{-3}

POPULATION NUMBERS

AGE	1976	1977	1978	1979	1980	1981
7	76884	50501	35757	19597	13731	10508
8	47978	61553	40982	29156	15863	11167
9	23704	37601	49469	33303	23096	12779
10	16529	18219	29448	40050	25650	18213
11	12855	12187	13422	23361	31466	19054
12	6301	9333	8689	9949	18313	24182
13	4070	4043	6349	6092	7795	13477
14	1514	2466	2491	4321	4790	5393
15	863	1007	1411	1613	3455	3469
16	440	582	440	922	1302	2600
17	194	312	167	194	749	910
18	75	124	130	78	150	572
19	65	37	27	56	63	93
7+	191471	197964	188783	168693	146423	122418
8+	114588	147463	153026	149096	132692	111910
9+	66610	85911	112043	119940	116829	100743
10+	42906	48309	62575	86636	93733	87964
11+	26377	30091	33126	46586	68082	69751
12+	13522	17904	19704	23225	36617	50697
13+	7221	8571	11015	13276	18304	26515
14+	3151	4527	4666	7184	10509	13038

Biomass in t

POPULATION BIOMASS (MID-YEAR)

AGE	1976	1977	1978	1979	1980	1981
7	20198	13354	7310	4734	4354	2295
8	14307	18578	10067	7725	4751	2608
9	8816	14111	14136	10962	7648	3330
10	7281	8022	10305	17223	8277	5602
11	6809	6400	5962	13415	12615	6210
12	3847	5856	4242	7786	9084	9547
13	3006	3010	4100	6439	5151	6396
14	1541	2341	2043	5347	3828	3236
15	1000	960	1385	2845	3497	2858
16	612	546	412	1632	1399	2696
17	290	385	192	310	1136	1136
18	112	133	148	138	245	860
19	123	57	44	100	125	186
7+	67940	73752	60344	78656	62109	46961
8+	47742	60398	53035	73922	57755	44666
9+	33436	41821	42968	66197	53005	42058
10+	24620	27710	28832	55235	45357	38727
11+	17339	19688	18527	38012	37080	33125
12+	10530	13288	12565	24597	24466	26915
13+	6683	7432	8323	16810	15381	17368
14+	3677	4422	4223	10371	10230	10972

FISHING MORTALITY

AGE	1976	1977	1978	1979	1980	1981
7	0.022	0.009	0.004	0.011	0.007	0.000
8	0.044	0.019	0.007	0.033	0.016	0.002
9	0.063	0.044	0.011	0.061	0.038	0.011
10	0.105	0.106	0.032	0.041	0.097	0.028
11	0.120	0.138	0.099	0.043	0.063	0.088
12	0.244	0.185	0.155	0.044	0.107	0.151
13	0.301	0.284	0.185	0.040	0.168	0.245
14	0.208	0.358	0.235	0.024	0.123	0.350
15	0.193	0.628	0.225	0.014	0.084	0.350
16	0.145	1.050	0.620	0.007	0.158	0.350
17	0.249	0.673	0.556	0.059	0.070	0.350
18	0.505	1.317	0.649	0.014	0.277	0.350
19	0.250	0.700	0.450	0.020	0.150	0.350

Table 16. Regression of mid-year biomass from VPA on CPUE, American plaice, Subarea 2+ Division 3K.

Year	CPUE (t/hr)	12+ Biomass (t) F_T = .2	F_T = .3	F_T = .4
1976	.395	12,637	11,140	10,392
1977	.402	17,989	14,465	12,707
1978	.375	18,618	14,014	11,719
1979	.467	37,909	27,660	22,557
1980	.525	39,226	27,845	22,171
1981	.970	47,101	31,495	23,685
r^2 1976-80		.836	.842	.841

Table 17. Regression of average F from VPA on directed effort, American plaice, Subarea 2 + Division 3K.

Year	Directed effort (hr)	Average F, age 14-18 F_T = .2	F_T = .3	F_T = .4
1976	15,440	.256	.256	.256
1977	18,674	.766	.780	.791
1978	9,392	.395	.417	.434
1979	6,377	.017	.019	.021
1980	9,587	.090	.113	.132
1981	7,519	.200	.300	.400
r^2 1976-80		.657	.636	.621

Table 18 Projection to 1983 using population in 1981 from VPA run at F_T = 0.3, American plaice, Subarea 2 + Division 3K. Numbers x 10^{-3}, Biomass in t.

POPULATION NUMBERS

	1981	1982	1983
7	30500	30500	30500
8	13026	24970	24839
9	14898	10644	20282
10	21207	12088	8577
11	22098	16951	9587
12	27928	16785	12989
13	15469	20098	12263
14	6150	10266	13670
15	3956	3730	6449
16	2965	2399	2343
17	1038	1798	1507
18	652	630	1130
19	106	395	396
7+	159993	151256	144533
8+	129493	120756	114033
9+	116467	95785	89193
10+	101569	85141	68911

POPULATION BIOMASS (AVERAGE)

	1981	1982	1983
7	6661.98	7692.84	7688.89
8	3043.10	6876.26	6834.91
9	3885.37	3503.88	6666.40
10	6535.88	4704.21	3327.67
11	7244.96	8006.65	4499.85
12	11137.86	9651.92	7388.89
13	7461.84	14526.63	8711.06
14	3774.90	9014.73	11714.68
15	3334.13	4077.91	6880.56
16	3145.24	2957.01	2818.23
17	1325.78	2519.76	2061.05
18	1003.00	993.48	1739.63
19	217.33	730.77	713.41
7+	58771.37	75256.03	71045.25
8+	52109.39	67563.19	63356.35
9+	49066.30	60686.93	56521.44
10+	45180.93	57183.06	49855.04

CATCH NUMBERS

	1981	1982	1983
7	1	146	175
8	23	179	214
9	121	152	348
10	456	343	291
11	1449	986	665
12	3070	1641	1508
13	2665	3093	2226
14	1452	2175	3393
15	934	790	1601
16	700	508	582
17	245	381	374
18	154	133	280
19	25	84	98
7+	11295	10611	11755
8+	11294	10465	11579
9+	11271	10286	11366
10+	11150	10134	11018

CATCH BIOMASS

	1981	1982	1983
7	0	41	49
8	6	55	65
9	35	56	127
10	157	150	127
11	543	530	358
12	1437	1099	1010
13	1567	2694	1939
14	1133	2388	3725
15	1000	1080	2188
16	944	783	896
17	398	668	655
18	301	263	553
19	65	194	227
7+	7585	10000	11920
8+	7585	9959	11872
9+	7579	9905	11806
10+	7544	9849	11679

FISHING MORTALITY

	1981	1982	1983
7	0.000	0.005	0.006
8	0.002	0.008	0.010
9	0.009	0.016	0.019
10	0.024	0.032	0.038
11	0.075	0.066	0.080
12	0.129	0.114	0.137
13	0.210	0.185	0.223
14	0.300	0.265	0.318
15	0.300	0.265	0.318
16	0.300	0.265	0.318
17	0.300	0.265	0.318
18	0.300	0.265	0.318
19	0.300	0.265	0.318
7+	0.085	0.084	0.100

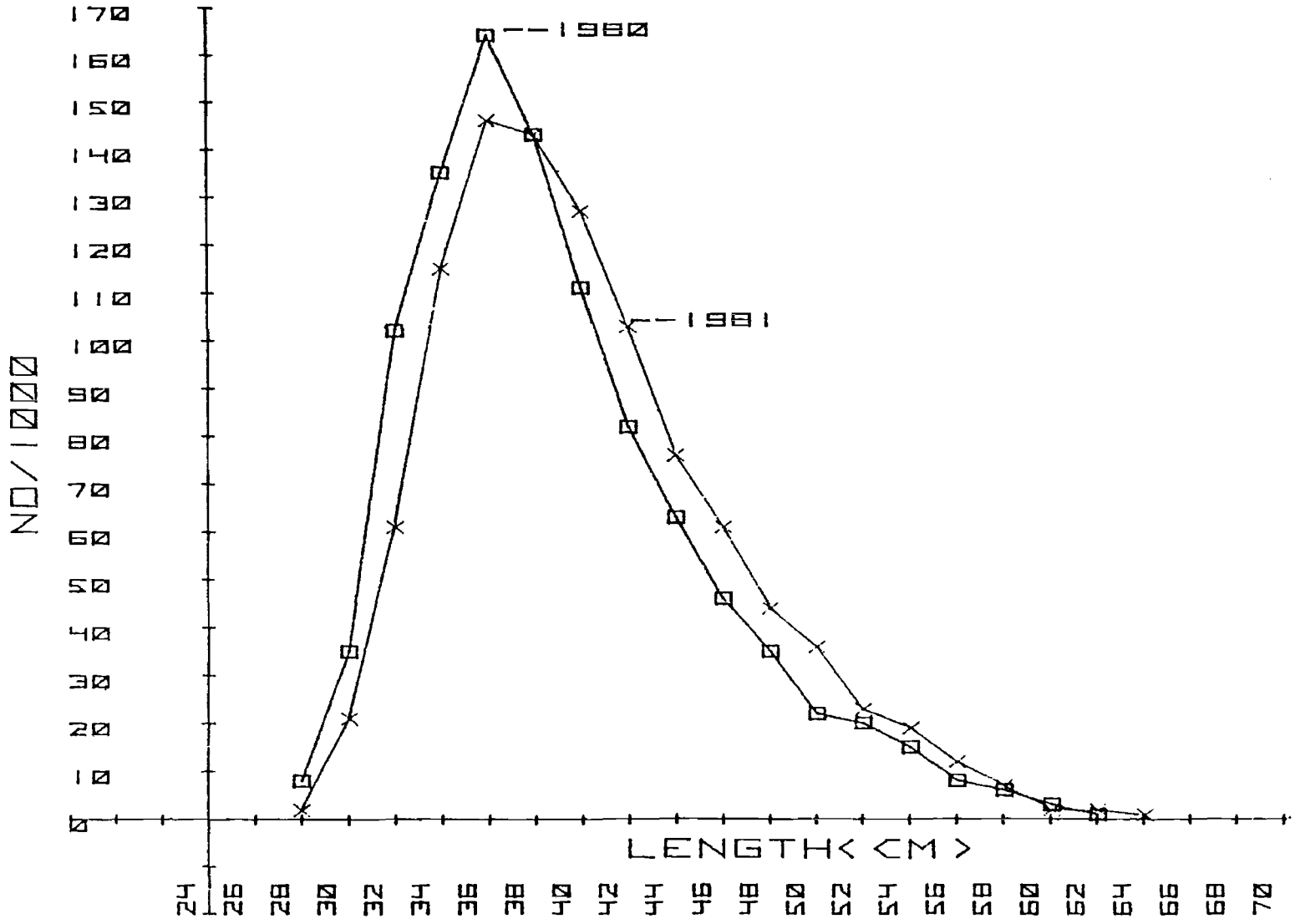

Fig. 1. Catch composition by length of American plaice, Subarea 2+Division 3K, 1980-81, Canada-N OT-5, January-April.

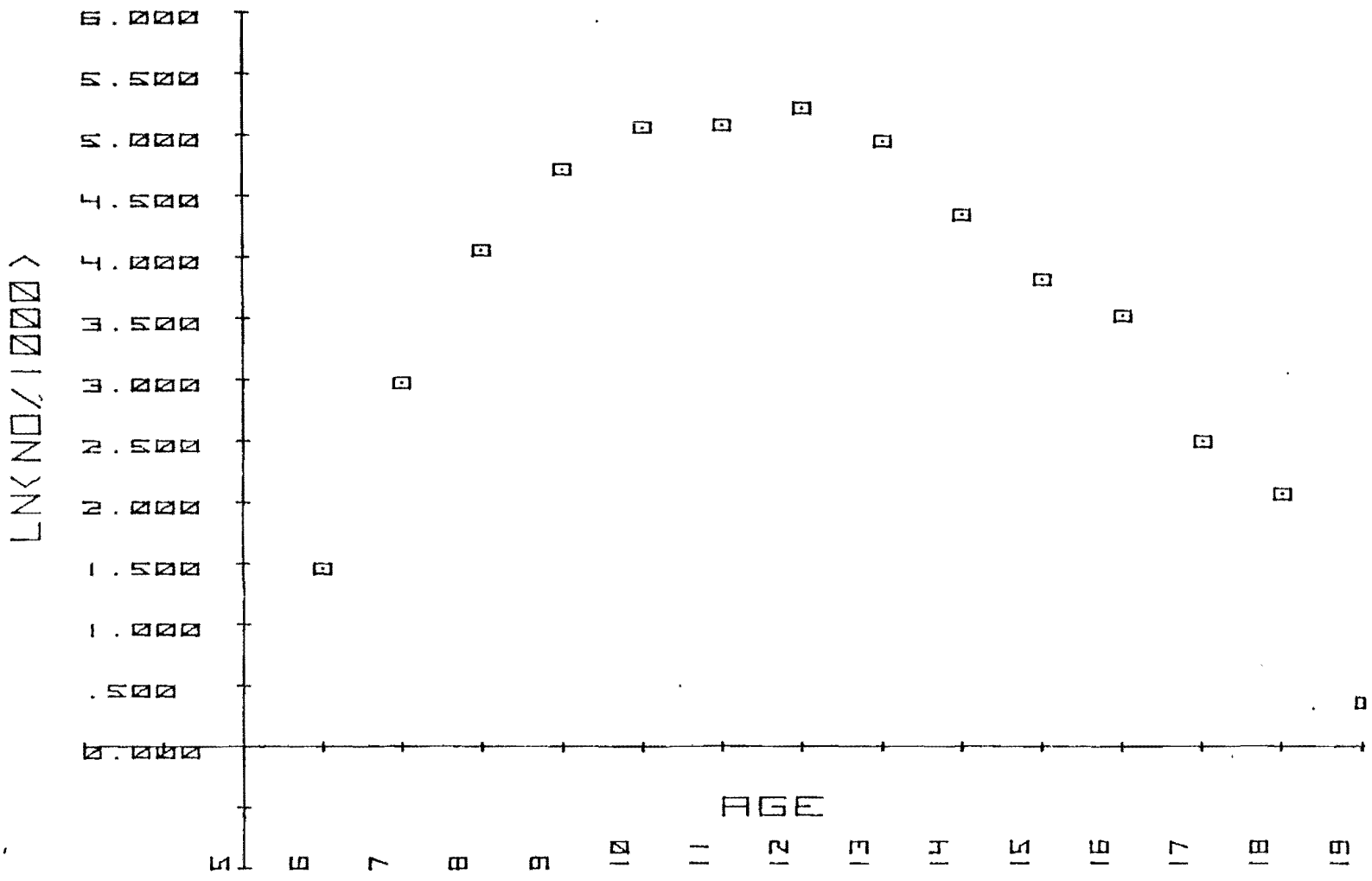

Fig. 2. Catch curve for American plaice in Subarea 2+Div. 3K, 1977-81. $\hat{Z}$ (ages 12-18)=0.542, r^2=0.980

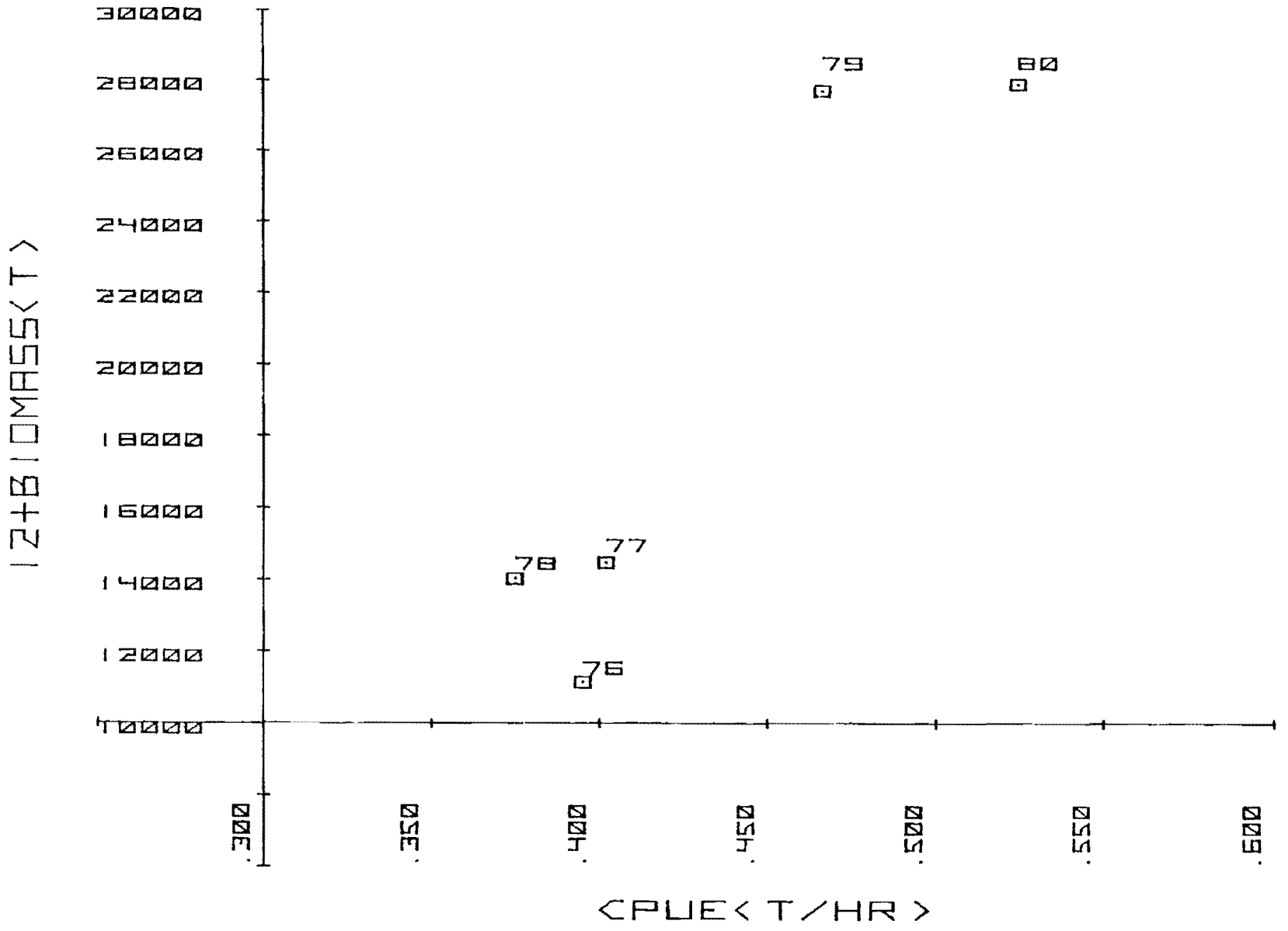

Fig. 3. Regression of age 12+ biomass from VPA at F_T=0.3 on CPUE for American plaice, Subarea 2+Div 3K.

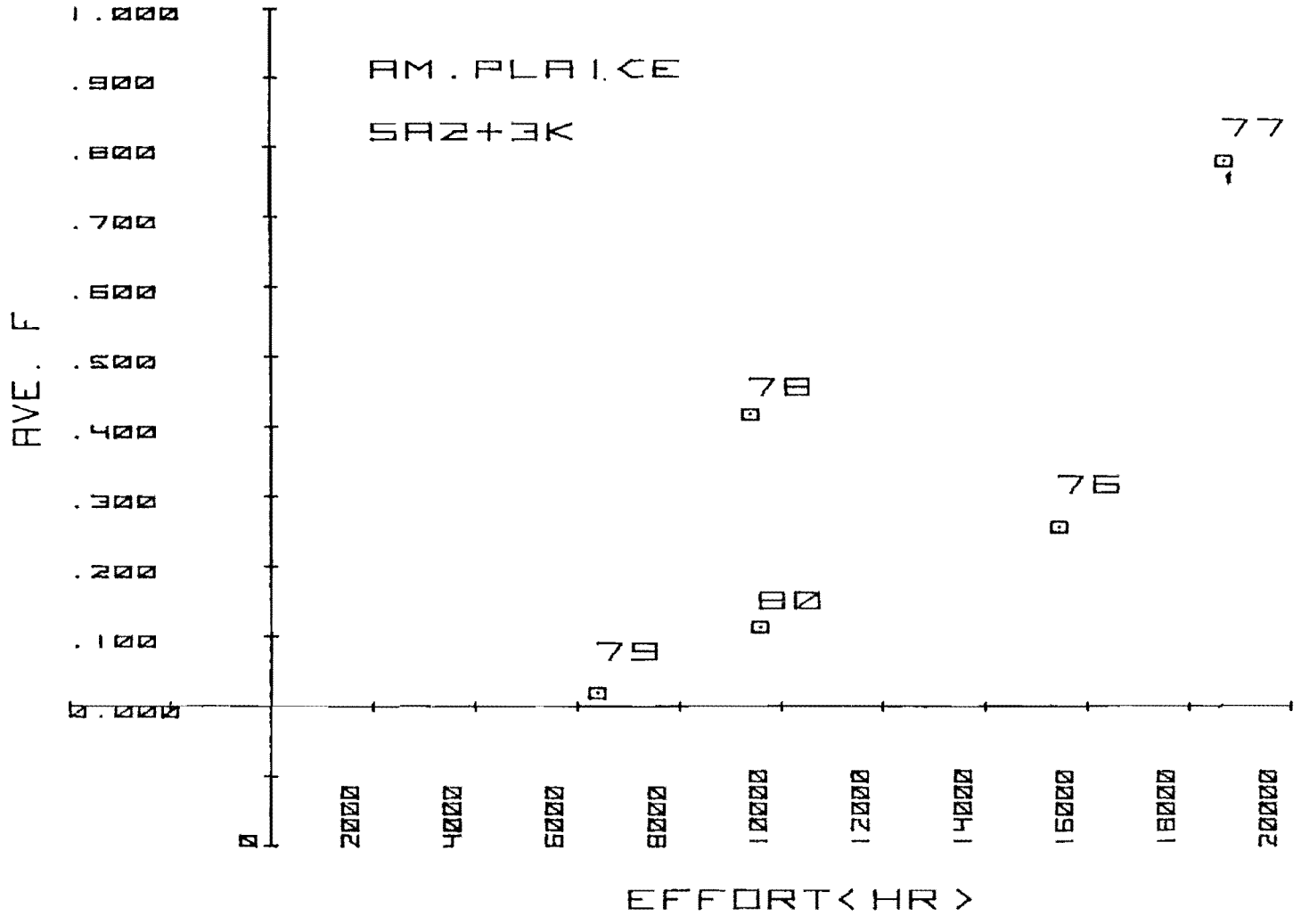

Fig. 4. Regression of fully recruited F from VPA at F_T=0.3 on effort for American plaice, Subarea 2+Div 3K.