Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC
Res. Doc. 81/ 51

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

by

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ABSTRACT

Although only 5 years data were available a Virtual Population Analysis was attempted. Total mortality rates calculated from survival rates using research vessel catch per set and catch curves from commercial data indicated relatively low fishing mortality in recent years. Catch rates by the commercial fleet have increased in the past two years.

RESUME

Bien qu'on ait disposé de données sur une période de seulement 5 ans, nous avons tenté une analyse de population virtuelle. Les taux de mortalité totale, calculés à partir des taux de survie découlant des prises par trait de chalut des navires de recherche et des courbes de capture des bateaux de pêche commerciale, indiquent un taux de mortalité par pêche relativement faible ces dernières années. Les taux de capture de la flottille de pêche commerciale ont augmenté ces deux dernières années.

INTRODUCTION

This stock has been managed by catch quota regulation since 1974. As indicated in Table 1, the highest recorded nominal catch was in 1970, (12,700 t) mainly because of the large reported catch by the USSR. However, prior to 1973, plaice landings were included in the "unspecified flatfish" category and only later separated into the various flatfish species. There is, therefore, serious question concerning the reliability of pre-1973 landings data. TAC's since 1973 are listed below ($t \times 10^{-3}$):

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

The reduction in the TAC from 8000 t in 1977 to 6000 t in 1978 was based on average catches 1974-75 that appeared to be generating fishing mortality (estimated from catch curves) at about $F_{0.1}$ (approximately 0.3, sexes combined).

Up to 1976 nearly all the Canadian landings were by inshore gears and although some samples were available, the inshore gear sampled only the larger fish and was not comparable to the catches made by the offshore foreign component. In 1976 a small directed otter trawler fishery for American plaice in Divisions 2J-3K occured mainly during October-December (Tables 1 and 2). In 1977 there was a directed fishery during the first quarter, however, in 1978 and 1979 the offshore fishery was again reduced.

In 1980 the directed trawler fishery increased substantially and the offshore fishery was closed. The trawler allocation of 3000 t was exceeded (3728 t) (Table 2). For the first three months of 1981, 5200 t have been landed by the trawler component, 90% in the directed fishery. Catch rates have doubled from 1980 (Table 2) and some vessels reported catches up to 30 t/day fished. It should be noted that ice conditions were exceptionally favourable in 1981.

STOCK ASSESSMENT

Numbers at age were available from 1976-80 (Table 7). The 1976 and 1977 sampling performance was low, however, in 1978 to 1980 adequate samples were available. A summary of the 1980 sampling is listed in Table 3.

Weights at age were calculated from the average lengths in the monthly commercial samples weighted by the numbers caught to give an annual weight at age (Table 4b).

Partial recruitment was derived from a preliminary cohort run using the catch number matrix 1977-80. This run calculates average F's across years to give a starting value for each cohort in 1980. The partial recruitment rates were calculated from these averages in 1980 and plotted with a line drawn by eye to give the values listed in Table 4b.

Yield per recruit was evaluated using the average weights and partial recruitment calculated for 1980. The average weights were almost identical to the 1978 and 1979 values. Natural mortality (M) was assumed to be 0.20. $F_{0.1}$ was calculated to be 0.3 with no definable F Max (Table 4a).

Terminal F. (F_T). Determinations by the usual methods i.e. F on effort, biomass on CPUE was not possible for at least two reasons; (1) the shortness of the data series (5 years) and (2) the unreliability of the catch and effort data (Table 2) because of the small amount of directed fishing effort in 1976, 1978 and 1979 when total landings were mainly by-catches.

Total mortality. Survival rates from research vessel data (Table 5) indicated very low total mortality between catch/tow from Nov. 1979 to Nov. 1980, Z=0.30 for ages 7-17 and Z=0.25 for ages 11-17. Total mortality from survival rates calculated from catch/hour from commercial catch at age data 1979-80 (Table 6) produced negative values of Z (S=1.551 ages 11-18 and 1.10 ages 7-17).

A catch curve using percent fish caught at age 1977-80 (Fig. 1) gave at ages 10-18, Z=0.46 (F=0.26) and for ages 14-18, Z=0.59 (F=0.39).

DISCUSSION

The total mortality rates noted above represent total mortality at an earlier period. Reported catches 1967-72 averaged around 7200 t, but were somewhat lower in subsequent years. The unknown factor, with respect to total removals is the unreported by-catch of plaice, especially in the cod fishery by countries fishing only for cod, principally Spain and Portugal. Total mortality rates calculated from catch curves in 1974 (Pitt 1974) reflected mortality rates during the 1962-71 period and suggested a total mortality rate of about 0.5 (sexes combined) i.e. F=0.30.

The good fishing in 1980 and the very large increase in catch rates in 1981 (Table 2) suggests that the stock is increasing in abundance. Stock assessments for Div. 3LNO plaice indicated an increase in abundance especially in Division 3L and one would perhaps expect a similar increase in Division 3K. The size of plaice caught during the winter fishing in 1980 and 1981 was similar (Fig. 2).

Research vessel data are available for both divisions for 3 years only and as indicated below, population numbers for plaice 4 years and older from the same group of strata do not indicate an increase in abundance i.e:

Population (numbers X 10^{-6}) fall surveys

	Division 2J			Division 3K		
Year	(Upper)	Mean	(Lower)	(Upper)	Mean	(Lower)
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)

In providing advice for 1982, virtual population runs were made using F_T values for 1980 at 0.25, 0.30 and 0.35 and projections made at $F_{0.1}$ (0.30) for 1982 assuming that the TAC of 6000 t only would be taken in 1981. The cohort runs and the projections are given in Tables 8-13.

Projection to 1982 using a terminal F of 0.25 in 1980, assuming that the TAC of 6,000 t would be exceeded by about 2,000 t in 1981 and also assuming the geometric mean recruitment of 49.5 million fish (1976-79) at age 6 for 1980-82 gives an $F_{0.1}$ catch of 10,000 t in 1982.

Reference

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

Table 1. Nominal catches, American plaice, ICNAF Subarea 2+3K, 1967-80

Year	Canada Inshore	Canada Offshore	Canada Total	Poland	USSR (tons)	Other	Total
1967	395		395	1134	1701	414	3,644
1968	1023		1023	1889	2911	128	5,951
1969	1689		1689	867	4129	217	6,902
1970	3751		3751	378	8160	397	12,686
1971	2486		2486	233	2597	32	5,348
1972	1188	9	1197	849	6760	317	9,123
1973	1368	16	1384	225	3011	520	5,140
1974	462	106	568	91	4643	308	5,610
1975	813	46	859	95	4449	345	5,748
1976	1741	736	2477	118	3373	131	6,099
1977	1925	4691	6616	27	702	162	7,507
1978	1723	1452	3175	138	123	86	3,522
1979	1792	1063	2855	31	39	53	2,978
1980*	1120	3728	4848	49	44	54	4,995

*Provisional

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

Year	Total catch (tons)	Directed CPUE (t/hr)	Effort (hr)	Offshore (Canada)		January-March		
				Directed catch (tons)	Total catch (tons)	Directed catch (tons)	Total catch (tons)	Directed CPUE (t/hr)
1976	6,099	(0.395)	15,440	701	736	62	68	(0.392)
1977	7,507	0.402	18,674	3,628	4,691	3,174	4,209	0.399
1978	3,522	0.375	9,392	652	1,452	635	1,177	0.376
1979	2,978	0.467	6,377	315	1,063	181	447	0.612
1980	4,995	0.525	9,514	2,151	3,728	2,094	3,316	0.549
1981						4,655	5,226	1.023

Table 3. List of sampling for 1980, American plaice, Subarea 2+3K.

Quarter	Number measured		Number otoliths		Number samples	
	2J	3K	2J	3K	2J	3K
1	-	2,184	-	612	-	7
2	-	1,973	-	369	-	5

Table 4.

(a)

SUMMARY OF YIELD PER RECRUIT CALCULATED FROM
PARTIAL RECRUITMENT AND AVERAGE WEIGHT AT AGE
OVER AGES 6 TO 19

F	Y/R(KG)
0.001	0.0012
0.050	0.0510
0.100	0.0860
0.150	0.1101
0.200	0.1266
0.250	0.1380
0.300	0.1458
0.350	0.1512
0.400	0.1549
0.450	0.1574
0.500	0.1592
0.550	0.1604
0.600	0.1613
0.650	0.1619
0.700	0.1623
0.750	0.1626
0.800	0.1628
0.850	0.1630
0.900	0.1631
0.950	0.1632
1.000	0.1633
1.050	0.1634
1.100	0.1634
1.150	0.1635
1.200	0.1636
1.250	0.1636
1.300	0.1637
1.350	0.1638
1.400	0.1638
1.450	0.1639
1.500	0.1640
1.550	0.1641
1.600	0.1642
1.650	0.1643
1.700	0.1644
1.750	0.1645
1.800	0.1646
1.850	0.1647
1.900	0.1649
1.950	0.1650
2.000	0.1651

(b)

NATURAL MORTALITY= 0.20

NO.OF AGES= 14   FIRST AGE=   6

AGE	AVG.WT.(gm)	P.REC.
6	250.	0.010
7	336.	0.020
8	322.	0.030
9	372.	0.060
10	373.	0.120
11	435.	0.250
12	553.	0.430
13	758.	0.700
14	897.	1.000
15	1114.	1.000
16	1228.	1.000
17	1646.	1.000
18	1984.	1.000
19	2261.	1.000

F0.1 IS 0.307 AND Y/R IS   0.1466
CURVE CONTINUES TO RISE. FMAX IS GREATER THAN 2.0

Table 5. Catch per tow of American plaice from research vessels, Divisions 2J+3K 1978-80 (research cruises November or early December in each year) and calculated total mortalities.

	Average number per set			
Age	1978	1979	1980	Calculations of Z
4	1.10	0.52	0.07	(1) $\dfrac{\Sigma\ 8\text{-}17\ (1980)}{\Sigma\ 7\text{-}16\ (1979)} = \dfrac{27.36}{36.93}$
5	8.26	3.29	0.49	
6	13.49	7.68	1.63	
7	14.76	12.57	11.79	S = 0.741
8	11.79	8.73	9.98	Z = 0.300
9	11.32	5.95	4.86	
10	6.75	3.62	4.36	(2) $\dfrac{\Sigma\ 12\text{-}17\ (1980)}{\Sigma\ 11\text{-}16\ (1979)} = \dfrac{4.76}{6.09}$
11	3.47	1.50	3.48	
12	3.68	2.76	2.56	
13	2.88	1.19	1.31	S = 0.782
14	1.33	0.46	0.53	Z = 0.246
15	1.34	0.12	0.20	
16	0.54	0.06	0.08	(3) $\dfrac{\Sigma\ 8\text{-}17\ (1979)}{\Sigma\ 7\text{-}16\ (1978)} = \dfrac{24.55}{57.86}$
17	0.14	0.16	0.08	
Total	80.85	48.61	41.42	S = 0.424
				Z = 0.857
				(4) $\dfrac{\Sigma\ 12\text{-}17\ (1979)}{\Sigma\ 11\text{-}16\ (1978)} = \dfrac{4.75}{13.24}$
				S = 0.359
				Z = 1.025

Table 6.   Calculation of survival rates from commercial catch/hour data, 1979-80, Divisions 2J+3K.   Effort calculated from CPUE Canada(N) OT-5.

Age	1979 Number/100 hr	1980 Number/100 hr	
6	42	11	
7	315	87	$\Sigma\ 12\text{-}18 = \dfrac{3982}{2567}$
8	1343	243	$\Sigma\ 11\text{-}17$
9	2807	812	
10	2299	2269	S = 1.551
11	1412	1841	Z = -0.439
12	610	1769	
13	343	1154	$\Sigma\ \ 8\text{-}17 = \dfrac{9147}{8317}$
14	144	528	$\Sigma\ \ 7\text{-}16$
15	33	266	
16	9	182	S = 1.100
17	16	48	Z = -0.095
18	2	35	
19	2	8	

Table 7.   Catch numbers matrix 1976-80 $(X\ 10^{-3})$.

CATCH AGE YEAR	1976	1977	1978	1979	1980
6	515.	131.	11.	27.	10.
7	1212.	403.	132.	201.	83.
8	1461.	1026.	277.	858.	231.
9	1034.	1481.	500.	1791.	772.
10	1171.	1657.	830.	1467.	2158.
11	1038.	1430.	1153.	901.	1751.
12	973.	1435.	1134.	389.	1682.
13	757.	911.	974.	219.	1097.
14	203.	677.	474.	92.	502.
15	108.	430.	259.	21.	253.
16	42.	349.	186.	6.	173.
17	31.	140.	65.	10.	46.
18	21.	84.	57.	1.	33.
19	10.	17.	9.	1.	8.

Table 8. Results of VPA runs at $F_T = 0.25$. (a) Population numbers. (b) F table. (c) Mean population biomass (tons). $(\times 10^{-3})$

(a) POPULATION NUMBERS

	1976	1977	1978	1979	1980
6	184373	105955	51163	22454	4419
7	77381	150486	86630	41879	18360
8	47231	62260	122844	70808	34106
9	22775	37350	50047	100326	57197
10	11057	17713	29243	40524	80522
11	7638	7997	13008	23193	31854
12	5020	5319	5260	9610	18175
13	2675	3235	3066	3287	7517
14	1485	1511	1830	1636	2494
15	776	1033	632	1073	1257
16	330	538	461	286	859
17	177	232	131	211	228
18	73	117	66	50	164
19	42	41	22	4	40
6+	361033	393787	364404	315340	257192
7+	176661	287832	313241	292886	252774
8+	99279	137345	226611	251007	234414
9+	52049	75086	103767	180200	200308

(b) FISHING MORTALITY

	1976	1977	1978	1979	1980
6	0.003	0.001	0.000	0.001	0.003
7	0.017	0.003	0.002	0.005	0.005
8	0.035	0.018	0.002	0.013	0.008
9	0.051	0.045	0.011	0.020	0.015
10	0.124	0.109	0.032	0.041	0.030
11	0.162	0.219	0.103	0.044	0.063
12	0.240	0.351	0.270	0.046	0.108
13	0.372	0.369	0.428	0.076	0.175
14	0.163	0.671	0.334	0.064	0.250
15	0.166	0.606	0.594	0.022	0.250
16	0.151	1.210	0.581	0.023	0.250
17	0.214	1.062	0.774	0.054	0.250
18	0.377	1.482	2.542	0.022	0.250
19	0.300	0.600	0.600	0.300	0.250
6+	0.028	0.033	0.021	0.021	0.039

(c) MEAN POPULATION BIOMASS

	1976	1977	1978	1979	1980
6	41714	23992	11592	5085	1000
7	23368	45762	26360	12721	5578
8	13555	18010	35808	20531	9918
9	7491	12325	16784	33503	19146
10	3523	5684	9736	13434	26831
11	2788	2842	4882	8953	12187
12	2246	2261	2321	4712	8653
13	1545	1869	1726	2177	4752
14	1117	904	1272	1290	1801
15	724	790	486	1072	1127
16	341	354	393	314	850
17	239	217	138	307	303
18	110	112	44	88	262
19	75	64	34	8	72
6+	98837	115189	111576	104194	92478
7+	57123	91197	99984	99110	91478
8+	33755	45434	73624	86389	85901
9+	20200	27424	37816	65858	75983

Table 9. Projection to 1980 from the VPA given in Table 8 using mean recruitment (G.M.) at age 6 1976-79 and projection to 1982 at $F_{0.1} = 0.3$. Population numbers X 10^{-3}, catch biomass in tons.

POPULATION NUMBERS

	1980	1981	1982
6	49500	49500	49500
7	18360	40518	40438
8	34106	14957	33028
9	57197	27715	12165
10	80522	46132	22393
11	31854	63977	36785
12	18175	24500	49575
13	7517	13364	18247
14	2494	5166	9378
15	1257	1590	3394
16	859	802	1045
17	228	548	527
18	164	145	360
19	40	105	95
6+	302273	289018	276929
7+	252773	239518	227429
8+	234413	199000	186991
9+	200307	184043	153964

POPULATION BIOMASS (AVERAGE)

	1980	1981	1982
6	11214.83	11204.11	11199.79
7	5577.72	12312.86	12279.05
8	9917.62	4351.18	9597.11
9	19145.45	9285.00	4066.11
10	26830.97	15398.17	7440.26
11	12187.04	24564.62	13989.67
12	8652.39	11734.61	23361.60
13	4751.43	8530.35	11346.49
14	1801.53	3783.76	6620.13
15	1127.65	1446.50	2975.27
16	849.40	803.67	1009.58
17	302.12	736.02	682.05
18	262.03	235.36	561.71
19	72.89	193.07	169.82
6+	102693.08	104579.28	105298.64
7+	91478.25	93375.17	94098.86
8+	85900.53	81062.31	81819.81
9+	75982.91	76711.14	72222.70

CATCH NUMBERS

	1980	1981	1982
6	10	99	134
7	83	161	219
8	231	89	268
9	772	330	197
10	2158	1091	718
11	1751	3108	2412
12	1682	2009	5450
13	1097	1734	3143
14	502	929	2214
15	253	286	801
16	173	144	247
17	46	98	124
18	33	26	85
19	8	19	23
6+	8799	10124	16036
7+	8789	10025	15901
8+	8706	9864	15682
9+	8475	9775	15414

CATCH BIOMASS

	1980	1981	1982
6	3	25	34
7	28	54	74
8	74	29	86
9	287	123	73
10	805	407	268
11	762	1352	1049
12	930	1111	3014
13	832	1315	2383
14	450	833	1986
15	282	318	893
16	212	177	303
17	76	162	205
18	65	52	169
19	18	43	51
6+	4824	6000	10586
7+	4822	5975	10552
8+	4794	5921	10479
9+	4719	5892	10392

FISHING MORTALITY

	1980	1981	1982
6	0.000	0.002	0.003
7	0.005	0.004	0.006
8	0.007	0.007	0.009
9	0.015	0.013	0.018
10	0.030	0.026	0.036
11	0.062	0.055	0.075
12	0.108	0.095	0.129
13	0.175	0.154	0.210
14	0.250	0.220	0.300
15	0.250	0.220	0.300
16	0.250	0.220	0.300
17	0.251	0.220	0.300
18	0.250	0.220	0.300
19	0.248	0.220	0.300
6+	0.034	0.041	0.069

Table 10. Results of VPA at $F_T = 0.3$ (as in Table 8)   (Population numbers = 10^{-3}, Biomass in tons.)

POPULATION NUMBERS

	1976	1977	1978	1979	1980
6	154936	88710	42714	18726	3683
7	65919	126386	72512	34961	15307
8	40833	52875	103112	59248	28442
9	20215	32112	42364	84171	47733
10	10238	15618	24955	34233	67296
11	7224	7326	11293	19682	26704
12	4737	4979	4712	8206	15301
13	2599	3003	2789	2838	6368
14	1431	1448	1641	1410	2126
15	763	989	581	918	1072
16	330	527	425	245	733
17	177	232	123	182	195
18	73	117	66	42	140
19	42	41	22	4	34
6+	309516	334365	307307	264868	215134
7+	154580	245654	264593	246142	211450
8+	88661	119269	192082	211181	196143
9+	47828	66393	88970	151932	167701

FISHING MORTALITY

	1976	1977	1978	1979	1980
6	0.004	0.002	0.000	0.002	0.003
7	0.020	0.004	0.002	0.006	0.006
8	0.040	0.022	0.003	0.016	0.009
9	0.058	0.052	0.013	0.024	0.018
10	0.135	0.124	0.037	0.048	0.036
11	0.172	0.241	0.119	0.052	0.075
12	0.256	0.380	0.307	0.054	0.129
13	0.385	0.404	0.482	0.089	0.210
14	0.170	0.713	0.381	0.075	0.300
15	0.169	0.644	0.666	0.026	0.300
16	0.151	1.258	0.650	0.027	0.300
17	0.214	1.062	0.860	0.063	0.300
18	0.377	1.482	2.542	0.026	0.300
19	0.300	0.600	0.600	0.300	0.300
6+	0.033	0.039	0.025	0.025	0.048

MEAN POPULATION BIOMASS

	1976	1977	1978	1979	1980
6	35044	20085	9677	4240	833
7	19877	38423	22061	10614	4648
8	11688	15271	30049	17157	8265
9	6628	10559	14193	28056	15955
10	3245	4975	8286	11307	22359
11	2624	2577	4205	7569	10156
12	2104	2090	2044	4008	7210
13	1492	1708	1533	1869	3960
14	1073	852	1117	1106	1501
15	710	744	433	916	939
16	341	341	352	269	708
17	239	217	124	263	252
18	110	112	44	75	218
19	75	64	34	8	60
6+	85252	98017	94153	87456	77065
7+	50207	77933	84476	83216	76232
8+	30330	39510	62415	72602	71584
9+	18642	24238	32366	55445	63319

Table 11. Projects to 1980 from VPA in Table 10. (Population X 10^{-3}, Population biomass in tons.)

	POPULATION BIOMASS (AVERAGE)				POPULATION NUMBERS		
	1980	1981	1982		1980	1981	1982
6	9402.13	9391.06	9389.72		41500	41500	41500
7	4647.98	10317.44	10289.38		15307	33968	33886
8	8264.61	3621.37	8037.62		28442	12457	27661
9	15954.50	7720.18	3381.48		47733	23078	10117
10	22359.33	12774.70	6176.67		67296	38383	18590
11	10155.89	20284.60	11569.86		26704	53149	30422
12	7210.42	9615.97	19165.00		15301	20284	40669
13	3959.88	6913.53	9192.83		6368	11011	14783
14	1500.67	3023.93	5265.98		2126	4226	7460
15	939.82	1145.79	2314.41		1072	1289	2640
16	708.37	636.98	778.39		733	650	805
17	252.62	583.79	526.18		195	445	406
18	218.63	187.23	433.66		140	118	278
19	60.53	153.23	131.50		34	85	74
6+	85635.37	86369.83	86652.66		252951	240644	229292
7+	76233.24	76978.77	77262.94		211451	199144	187792
8+	71585.25	66661.33	66973.56		196144	165176	153906
9+	63320.64	63039.93	58935.94		167702	152719	126245

	CATCH NUMBERS				CATCH BIOMASS				FISHING MORTALITY		
	1980	1981	1982		1980	1981	1982		1980	1981	1982
6	10	102	113		3	25	28		0.000	0.003	0.003
7	83	166	184		28	56	62		0.006	0.005	0.006
8	231	91	225		74	29	72		0.009	0.008	0.009
9	772	337	164		287	125	61		0.018	0.016	0.018
10	2158	1112	596		805	415	222		0.036	0.032	0.036
11	1751	3153	1995		762	1372	868		0.075	0.068	0.075
12	1682	2023	4471		930	1118	2472		0.129	0.116	0.129
13	1097	1727	2547		832	1309	1930		0.210	0.189	0.210
14	502	912	1761		450	818	1580		0.300	0.270	0.300
15	253	278	623		282	310	694		0.300	0.270	0.300
16	173	140	190		212	172	234		0.300	0.270	0.300
17	46	96	96		76	158	158		0.300	0.270	0.300
18	33	26	66		65	51	130		0.299	0.270	0.300
19	8	18	17		18	41	39		0.299	0.270	0.300
6+	8799	10181	13047		4824	6000	8551		0.040	0.049	0.068
7+	8789	10079	12934		4822	5975	8523				
8+	8706	9913	12750		4794	5919	8461				
9+	8475	9822	12526		4719	5889	8389				

Table 12. Results of VPA at $F_T = 0.35$ as in Tables 8 and 10. (Population X 10^{-3} biomass in tons).

POPULATION NUMBERS

	1976	1977	1978	1979	1980
6	133910	76393	36679	16063	3158
7	57733	109171	62427	30020	13127
8	36265	46173	89018	50992	24397
9	18388	28373	36877	72632	40974
10	9653	14122	21893	29741	57849
11	6928	6848	10069	17175	23026
12	4535	4737	4321	7204	13249
13	2545	2838	2591	2519	5547
14	1392	1404	1506	1249	1865
15	753	957	545	808	940
16	330	519	399	215	643
17	177	232	116	161	171
18	73	117	66	37	123
19	42	41	22	4	30
6+	272725	291926	266529	228820	185095
7+	138814	215533	229850	212757	181938
8+	81082	106361	167423	182737	168811
9+	44816	60188	78405	131746	144414

FISHING MORTALITY

	1976	1977	1978	1979	1980
6	0.004	0.002	0.000	0.002	0.004
7	0.023	0.004	0.002	0.007	0.007
8	0.045	0.025	0.003	0.019	0.011
9	0.064	0.059	0.015	0.028	0.021
10	0.143	0.138	0.043	0.056	0.042
11	0.180	0.261	0.135	0.060	0.088
12	0.269	0.403	0.340	0.061	0.151
13	0.395	0.433	0.530	0.101	0.245
14	0.175	0.746	0.423	0.085	0.350
15	0.172	0.674	0.729	0.029	0.350
16	0.151	1.296	0.710	0.031	0.350
17	0.214	1.062	0.935	0.071	0.350
18	0.377	1.482	2.542	0.030	0.350
19	0.300	0.600	0.600	0.300	0.350
6+	0.037	0.045	0.029	0.029	0.056

MEAN POPULATION BIOMASS

	1976	1977	1978	1979	1980
6	30280	17294	8310	3636	714
7	17384	33181	18990	9109	3984
8	10355	13315	25936	14748	7084
9	6012	9297	12343	24165	13675
10	3048	4469	7251	9788	19165
11	2507	2387	3722	6580	8705
12	2002	1967	1846	3506	6180
13	1454	1593	1394	1649	3394
14	1041	814	1006	975	1287
15	701	711	396	805	805
16	341	331	322	236	607
17	239	217	114	232	216
18	110	112	44	66	187
19	75	64	34	8	52
6+	75549	85753	81708	75503	66056
7+	45269	68459	73399	71866	65342
8+	27885	35278	54409	62757	61358
9+	17530	21963	28473	48009	54274

Table 13. Projection from the VPA in Table 12 (Population numbers X 10^{-3}, population biomass in tons.)

POPULATION NUMBERS

	1980	1981	1982
6	35500	35500	35500
7	13127	29056	28971
8	24397	10673	23636
9	40974	19766	8654
10	57849	32850	15872
11	23026	45415	25872
12	13249	17273	34296
13	5547	9332	12307
14	1865	3555	6093
15	940	1076	2106
16	643	542	638
17	171	371	321
18	123	99	220
19	30	71	58
6+	217441	205577	194544
7+	181941	170077	159044
8+	168814	141021	130073
9+	144417	130349	106437

Mean **POPULATION BIOMASS**

	1980	1981	1982
6	8042.61	8031.27	8032.17
7	3984.10	8820.87	8797.11
8	7084.09	3100.15	6868.00
9	13675.56	6602.22	2892.42
10	19165.24	10899.77	5273.58
11	8705.08	17224.05	9839.35
12	6180.44	8101.23	16161.58
13	3393.67	5759.09	7652.69
14	1286.81	2482.58	4301.04
15	805.49	933.38	1846.61
16	607.42	518.60	616.24
17	216.53	475.57	416.33
18	187.83	152.45	343.32
19	52.27	125.11	104.06
6+	73387.16	73226.34	73144.50
7+	65344.54	65195.07	65112.33
8+	61360.44	56374.20	56315.22
9+	54276.34	53274.05	49447.22

CATCH NUMBERS

	1980	1981	1982
6	10	104	96
7	83	170	157
8	231	93	192
9	772	344	140
10	2158	1133	509
11	1751	3200	1696
12	1682	2036	3770
13	1097	1719	2120
14	502	895	1438
15	253	271	497
16	173	137	151
17	46	93	76
18	33	25	52
19	8	18	14
6+	8799	10238	10909
7+	8789	10134	10813
8+	8706	9964	10655
9+	8475	9871	10463

CATCH BIOMASS

	1980	1981	1982
	3	26	24
	28	57	53
	74	30	62
	287	128	52
	805	423	190
	762	1392	738
	930	1126	2085
	832	1303	1607
	450	802	1290
	282	302	554
	212	168	185
	76	154	125
	65	49	103
	18	40	31
	4824	6000	7099
	4822	5974	7075
	4794	5917	7022
	4719	5887	6960

FISHING MORTALITY

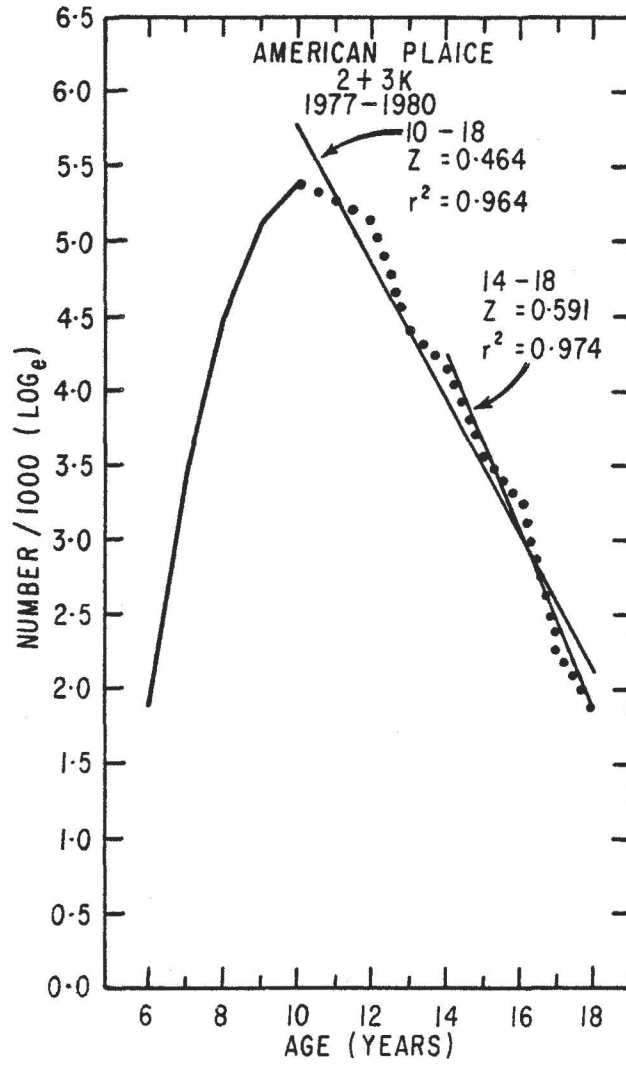|	1980	1981	1982
6	0.000	0.003	0.003
7	0.007	0.006	0.006
8	0.010	0.010	0.009
9	0.021	0.019	0.018
10	0.042	0.039	0.036
11	0.087	0.081	0.075
12	0.150	0.139	0.129
13	0.245	0.226	0.210
14	0.350	0.323	0.300
15	0.350	0.323	0.300
16	0.350	0.323	0.300
17	0.350	0.323	0.300
18	0.349	0.323	0.300
19	0.346	0.323	0.300
6+	0.048	0.059	0.067

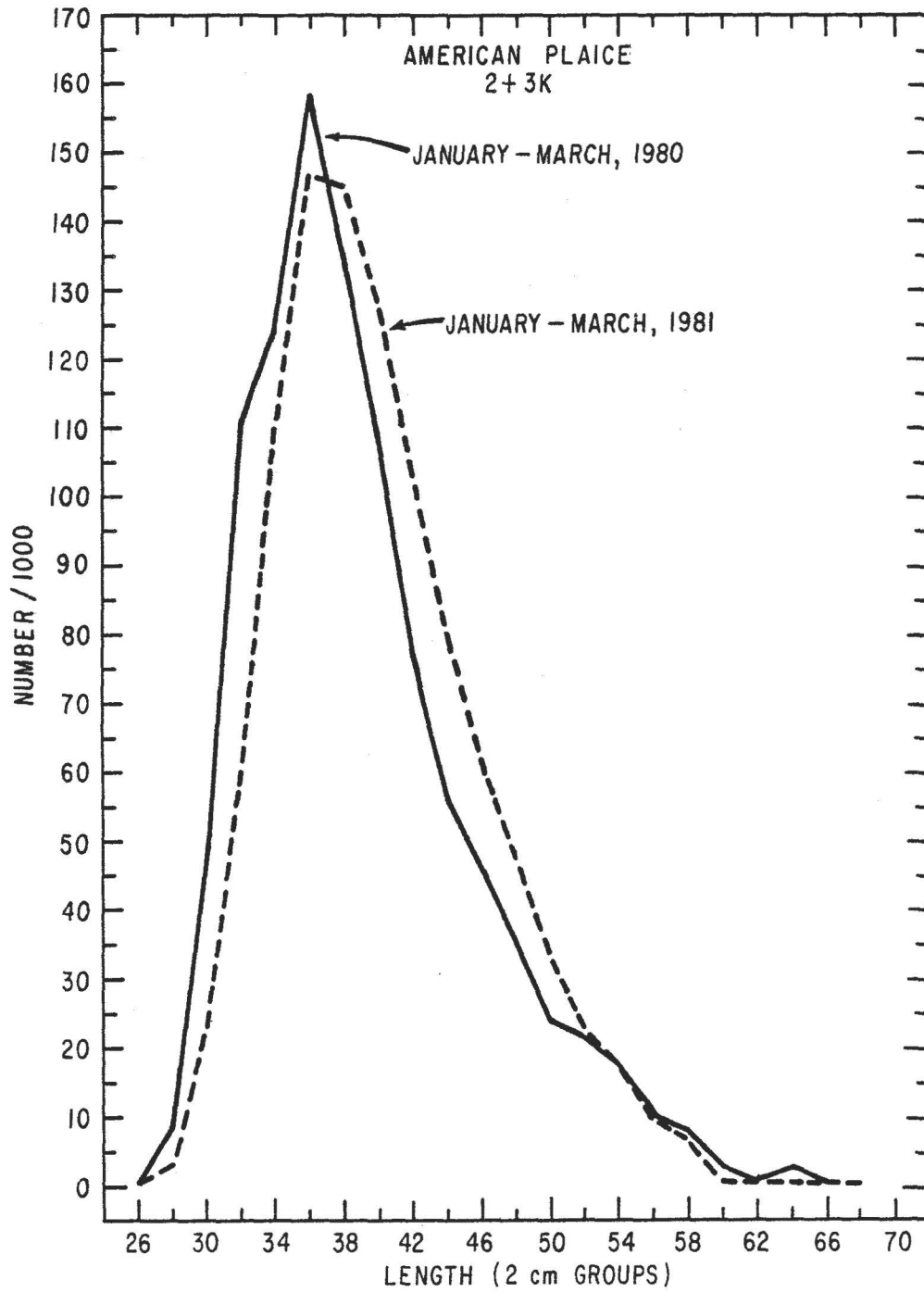Fig. 1. Catch curve of plaice 2+3K using 1977-80 catch at age data.

Fig. 2. Length frequencies of plaice, January-March, 1980 and 1981.