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A Stock Assessment Update of American Plaice in NAFO Divisions 3L, 3N and 3O

by

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INTRODUCTION

This stock has been commercially exploited since the early 1950's, however, it did not come under a management scheme until 1973 when the first stock assessment resulted in the establishment of a total allowable catch (Table 1).

Nominal catches from this stock for 1965-80 and TAC for 1973-81 are listed in Table 1 and 2.

ASSESSMENT

NUMBERS CAUGHT AT AGE

The catch matrix (Table 9) includes data from 1960-80. The numbers caught in 1980 were calculated in the usual way from the commercial sampling (Table 3) and the nominal monthly catches. Quarterly age-length keys were applied to the monthly length frequencies when available.

AVERAGE WEIGHT AT AGE

Average weights at age for the current year (1980) were calculated from average length at age and converted to weights by a length weight equation. For the calculation of the yield per recruit (Table 4) average weight at age (1960-80) was used. The 1980 weights were used to make the 1981 and 1982 projections. Weight at age (1960-80) is listed in Table 5.

PARTIAL RECRUITMENT

Partial recruitment rates for 1980 were determined from a preliminary cohort run using numbers at age 1977-80. This resulted in values similar to those used in the 1980 assessment (Pitt and Brodie 1980). For the yield per recruit calculation average F's 1960-78 were used (Table 4). The 1980 partial recruitment values (current year) were used to project catches and biomass for 1981 and 1982. A listing of partial recruitment values calculated using the 1980 data and a comparison with those used last year are listed below together with the average weight at age for the 1980 sampling.

Age	6	7	8	9	10	11	12	13	14	15	16	17
P/R '80	.04	.15	.30	.40	.60	.75	.80	1.0	1.0	1.0	1.0	1.0
'79	.07	.14	.25	.34	.50	.61	.75	1.0	1.0	1.0	1.0	1.0
$\bar{W}$ (kg)	.328	.410	.483	.537	.570	.653	.742	.989	1.352	1.739	1.770	2.140

Age	18	19
P/R '80	1.0	1.0
'79	1.0	1.0
$\bar{W}$ (kg)	2.700	2.700

TERMINAL FISHING MORTALITY

Terminal fishing mortality (F_T) was estimated by three methods.

(a) Catch per hour on biomass from VPA (ages 8-18) for three values of F_T 0.25, 0.30 and 0.35 are listed in Table 6 and the plot for 0.35 is given in Fig. 1. The latter value for F_T gives the highest r^2 and also produces the best predicted value for the observed biomass in 1980, however, the correlation coefficients for all three runs are similar. As indicated in Fig. 2 and Table 6 the CPUE in 1980 (0.579 t/hr) was at a level between the rates recorded in 1968 and 1969 (0.629 and 0.548 t/hr). The biomass (8-18 years) during the latter period was calculated to be between 234 and 267 thousand tons which is approximately the level indicated for 1980 by the VPA run at $F_T = 0.30$, i.e. 245 thousand tons.

(b) Weighted F (ages 8-18) on directed fishing effort for three levels of F_T are listed in Table 7. Again the run initiated by $F_T = 0.35$ gives the best fit, however, the correlation coefficients are all quite similar and highly significant. The best predicted value for 1980 is produced by the VPA run initiated by $F_T = 0.3$. The latter values are given in Fig. 3.

(c) Population numbers from VPA on research vessel abundance estimates for ages 8-18 (Table 8 and Fig. 4) for the same three VPA runs again produce highly significant values of r2 and although the r^2 produced by the 0.35 run is marginally higher, the 0.30 value produces the closest predicted value. Unfortunately, 1973 and 1976 had incomplete surveys.

Results and Discussion

As shown in Fig. 2 and Table 18, the CPUE in the directed A. plaice fishery in Division 3LNO has indicated a consistent upward trend since 1977. Population numbers have stabilized somewhat since 1977 (Table 11), however the apparent increased recruitment in the last few years is having its effect on the catch biomass with more yield being taken from the older age groups (e.g. ages 9+, Table 10). Research vessel abundance indices (Table 17) suggest that recruitment has leveled off. However, the research vessel gear used for the Grand Bank surveys apparently does not adequately sample the youngest age groups, hence it is doubtful if the 4 and 5 year olds in Table 17 are indicative of the real abundance of these age groups.

Although numbers at age are available from 1960-1980, the pre-1965 data were not used in the V.P.A. because prior to 1965 sampling of the commercial catch was at a relatively low level and additionally the weight-at-age data were considered to be unreliable hence the calculation of biomass prior to 1965 was unacceptable for correlation with commercial CPUE.

The VPA run for Division 3LN using a F_T 0.30 and the partial recruitment vector calculated for 1980 is given in Tables 9-15. The assessment presented at the 1980 STACFIS Meeting (Pitt and Bodie, 1980) projected a catch of 40,000 t at a fishing mortality of 0.23 in the fully recruited age group, whereas the actual recorded catch was approximately 45,000 t. A projection for Divisions 3LN in Table 16 projected a catch biomass of about 45,000 t in 1982 at $F_{0.1}$ (0.26) from a population in 1980 calculated from a F_T of 0.3, and assuming 48,000 t will be taken in 1981. Recruitment for 1981 and 1982 was the GM at age 6 1976-79.

A total TAC for Division 3LNO would have to include an amount for 30 in addition to the 3LN projection.

Table 1. Nominal catches of American plaice for ICNAF Divisions 3LNO 1966-79.

Year	Canada	France	Poland	USSR	Other	Total	TAC
1966	51,225	1246	860	11,484	196	65,011	
1967	54,190	1326	3234	35,139	524	94,413	
1968	48,674	406	203	23,751	133	73,167	
1969	64,815	43	34	14,493	52	79,437	
1970	54,929	389	40	10,232	1055	66,645	
1971	49,394	323	370	17,173	628	67,888	
1972	41,605	322	2515	14,164	755	59,361	
1973	38,586	310	1116	12,516	319	52,843	60,000
1974	35,101	418	615	10,074	89	46,297	60,000
1975	34,015	442	537	7682	545	43,221	60,000
1976	47,806	305	5	3280	429	51,825	47,000
1977	42,579	31	0	1023	349	43,982	47,000
1978	48,634	168	0	1048	178	50,028	47,000
1979	47,131	113	0	1190	138	48,572	47,000
1980*	48,407				638	49,095	47,000
1981							55,000

*Provisional

Table 2. Breakdown of plaice nominal catches in Divisions 3LNO by Division (metric tons).

Year	Division 3L	Division 3N	Division 3Ø	Total
1965	25,034	26,270	1957	53,279
1966	18,572	34,698	11,741	65,011
1967	38,515	24,364	31,534	94,413
1968	39,126	20,038	14,003	73,167
1969	52,880	14,442	12,115	79,437
1970	39,347	21,032	6266	66,645
1971	37,851	22,873	7164	67,888
1972	33,330	17,387	8644	59,361
1973	20,103	20,883	11,857	52,843
1974	16,609	21,118	8561	46,297
1975	15,171	21,308	6742	43,221
1976	25,112	18,623	8080	51,825
1977	23,763	16,543	3675	43,981
1978	30,145	13,443	6440	50,028
1979	28,710	14,712	5150	48,572
1980	31,870	15,308	1917	49,095

Table 3. List of commercial sampling for 1980.

Quarter	Measurements			Otoliths			Catch			No. Samples		
	3L	3N	30	3L	3N	3Ø	3L	3N	30	3L	3N	3Ø
1	3717	1409	448	433	276	104	1676	872	419	6	3	1
2	22,985[1]	1608	1094	790[1]	382	336	13,156	2225	328	37[1]	5	3
	2788[2]			503[2]			2040			9[2]		
3	3223[1]	7390	-	663[1]	864	-	2603	3945	145	9[1]	20	
	2644[2]			519[2]			1271			8[2]		
4	4330[1]	9362	589	706[1]	708	191	7877	7130	953	11[1]	18	2
	2128[2]			588[2]			104			6[2]		
Total	41,855	19,769	2131	4202	2230	631				86	46	6

Table 4. SUMMARY OF YIELD PER RECRUIT CALCULATED FROM PARTIAL RECRUITMENT AND AVERAGE WEIGHT AT AGE OVER AGES 5 TO 20

F	Y/R (KG)
0.001	0.0018
0.050	0.0710
0.100	0.1158
0.150	0.1445
0.200	0.1631
0.250	0.1753
0.300	0.1835
0.350	0.1891
0.400	0.1931
0.450	0.1960
0.500	0.1982
0.550	0.1999
0.600	0.2013
0.650	0.2025
0.700	0.2035
0.750	0.2043
0.800	0.2051
0.850	0.2058
0.900	0.2064
0.950	0.2070
1.000	0.2075
1.050	0.2080
1.100	0.2085
1.150	0.2089
1.200	0.2093
1.250	0.2097
1.300	0.2101
1.350	0.2104
1.400	0.2108
1.450	0.2111
1.500	0.2114
1.550	0.2116
1.600	0.2119
1.650	0.2121
1.700	0.2124
1.750	0.2126
1.800	0.2128
1.850	0.2130
1.900	0.2132
1.950	0.2134
2.000	0.2136

NATURAL MORTALITY= 0.20

NO.OF AGES= 16 FIRST AGE= 5

AGE	AVG.WT.	P.REC.
5	209.	0.005
6	261.	0.025
7	341.	0.010
8	428.	0.220
9	552.	0.300
10	625.	0.470
11	700.	0.580
12	880.	0.730
13	1020.	1.000
14	1250.	1.000
15	1524.	1.000
16	1803.	1.000
17	2022.	1.000
18	2233.	1.000
19	2401.	1.000
20	2428.	1.000

F0.1 IS 0.264 AND Y/R IS 0.1779
CURVE CONTINUES TO RISE. FMAX IS GREATER THAN 2.0

Table 5. AM, PL, WEIGHT MATRIX

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
6	0.193	0.189	0.177	0.227	0.285	0.289	0.277	0.287	0.276	0.290
7	0.274	0.279	0.276	0.297	0.378	0.365	0.369	0.383	0.348	0.332
8	0.363	0.373	0.380	0.384	0.491	0.498	0.499	0.469	0.450	0.412
9	0.487	0.493	0.522	0.525	0.547	0.625	0.640	0.610	0.602	0.564
10	0.594	0.596	0.611	0.621	0.639	0.703	0.788	0.788	0.697	0.670
11	0.695	0.741	0.738	0.731	0.760	0.827	0.976	0.847	0.851	0.785
12	0.857	0.865	0.885	0.845	0.851	0.869	0.988	1.030	0.991	0.982
13	0.903	0.888	0.905	0.867	0.920	0.932	0.984	1.064	1.075	1.050
14	1.193	1.199	1.206	1.152	1.208	1.258	1.287	1.369	1.397	1.401
15	1.262	1.264	1.272	1.255	1.289	1.377	1.413	1.631	1.597	1.602
16	1.308	1.324	1.330	1.541	1.596	1.614	1.656	1.890	1.881	1.870
17	1.411	1.423	1.423	1.872	1.921	1.905	1.922	2.166	2.197	2.240
18	1.516	1.516	1.525	1.891	1.934	1.943	1.917	2.305	2.297	2.348
19	1.562	1.558	1.572	1.962	1.997	1.957	2.025	2.527	2.488	2.595

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
6	0.275	0.259	0.278	0.244	0.252	0.248	0.261	0.264	0.266	0.320	0.328
7	0.330	0.331	0.372	0.292	0.339	0.347	0.345	0.359	0.363	0.374	0.410
8	0.397	0.404	0.484	0.380	0.416	0.418	0.403	0.431	0.414	0.448	0.483
9	0.536	0.494	0.527	0.519	0.568	0.578	0.548	0.623	0.515	0.546	0.537
10	0.680	0.612	0.629	0.629	0.694	0.706	0.658	0.676	0.618	0.594	0.570
11	0.795	0.772	0.753	0.816	0.917	0.922	0.841	0.884	0.773	0.683	0.653
12	0.841	0.909	0.867	1.041	1.108	1.099	1.029	1.013	0.928	0.906	0.742
13	1.043	1.034	0.935	1.243	1.360	1.339	1.152	1.199	1.199	1.188	0.989
14	1.166	1.132	1.175	1.334	1.567	1.536	1.327	1.389	1.389	1.659	1.352
15	1.311	1.279	1.380	1.524	1.922	1.813	1.658	1.768	1.768	1.886	1.739
16	1.673	1.600	1.654	1.816	2.387	2.319	2.137	2.196	2.196	2.118	1.770
17	1.854	1.911	1.854	1.939	2.458	2.578	2.318	2.324	2.324	2.302	2.140
18	2.073	2.117	1.915	2.104	2.871	2.880	2.716	2.546	2.546	3.199	2.700
19	2.283	2.285	2.129	2.294	3.004	2.942	2.864	3.072	3.072	3.243	3.000

Table 6. CPUE (t/hr) and biomass from VPA ages 8-18 (tons 10^{-}).

Year	CPUE t/hr		F_T for VP runs .25	.30	.35
1966	0.876		311.8		
1967	0.817		293.1		
1968	0.629		266.8		
1969	0.548		234.2		
1970	0.516		194.5		
1971	0.479		160.1		
1972	0.481		137.5	136.9	136.4
1973*	0.571		116.7	115.5	114.6
1974	0.434		128.3	125.6	123.6
1975	0.416		144.4	138.9	134.9
1976	0.430		167.3	156.0	148.0
1977	0.412		214.3	193.8	179.2
1978	0.460		229.3	201.4	181.3
1979	0.495		277.5	237.4	208.7
1980	0.579		294.2	245.1	210.1
1966-78		r^2	0.746	0.833	0.872
		Intercept	36.124	14.256	-1.419
		slope	323.539	352.232	372.797
		Predicted '80	277.5	218.2	214.4
1966-80		r^2	.583	0.777	0.857
		Intercept	51.346	23.270	3.154
		slope	317.064	346.380	367.408
		Predicted '80	229.8	223.8	215.9

*omitted

Table 7. Weighted F (ages 8-18) and effort for American plaice Divisions 3LN 1965-80. F weighted by the population. VPA runs at the indicated F_T's.

Year	Effort $X10^{-3}$		Terminal F_T 0.25	0.30	0.35
				Weighted F	
1965	56.2		.122		
1966	60.7		.127		
1967	77.0		.163		
1968	94.1		.181		
1969	122.9		.232		
1970	117.0		.236		
1971	126.8		.282	.283	.283
1972*	105.4		.319	.320	.322
1973*	79.3		.306	.315	.314
1974	96.9		.204	.210	.213
1975	92.5		.176	.184	.190
1976	101.7		.203	.220	.232
1977	96.1		.140	.155	.169
1978	94.8		.137	.158	.176
1979	87.7		.115	.136	.154
1980	81.5		.127	.153	.179
1965-78		r	0.760	.834	.877
		Intercept	-0.003	.0001	.003
		slope	0.002	.002	.002
Predicted '80			0.157	.162	.167
1965-79		r^2	0.705	.799	.860
			-0.013	-.007	.002
			0.002	.002	.002
Predicted '80			0.152	.159	.165
1965-80		r^2	0.709	.806	0.818
		Intercept	-0.020	-.009	-.005
		slope	0.002	.002	.002
Predicted '80			0.150	.159	.166

Table 8. Population numbers (ages 8-18) from VPA on comparable data from research vessel surveys. Blanks indicate inadequate coverage by R/V.

Year	3L	3N	Terminal F 3LN	.25	.30	.35
	$\times 10^{-6}$				$\times 10^{-6}$	
1971	206.5	35.0	241.5	309.2	308.7	308.0
1972	146.1	30.5	176.6	263.8	262.6	261.7
1973	-	23.8	-	234.4	231.5	229.5
1974	134.6	19.0	153.6	236.7	230.8	226.5
1975	154.8	15.0	169.9	277.3	265.7	257.4
1976	327.3	-	-	367.3	342.7	374.4
1977	372.5	36.0	408.5	420.0	380.1	351.7
1978	263.2	32.4	295.6	490.3	432.6	391.4
1979	300.4	27.4	339.8	562.9	485.2	429.8
1980	325.8	29.2	355.0	587.5	495.5	429.8
	1971-79*		r^2	0.935	0.935	0.932
			Intercept	-39.949	23.500	68.608
			slope	1.728	1.333	1.063
	Predicted		1980	573.6	499.2	445.9
	1971-80*		r^2	0.956	0.978	0.980
			Intercept	-46.710	25.290	76.323
			slope	1.764	1.330	1.022
	Predicted		1980	579.4	497.6	439.2

*1977 point not used.

Table 9.

AM PL CATCH MAT

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
6	309	189	428	960	1788	3041	5139	2228	1894	2079	1968	1565
7	816	501	632	1740	4662	6969	8224	7216	3347	6674	2314	7524
8	1324	1161	1054	1337	3035	8964	9122	5093	7913	12023	9066	9354
9	1685	2324	1139	1442	5760	6789	7798	6330	9065	15409	12264	13868
10	2210	2994	1605	2086	8180	7285	5954	9133	9405	10830	10225	12670
11	2462	2327	2339	2894	6493	5521	5823	9106	6255	10793	10128	9833
12	3367	2143	2594	3892	5737	5578	4644	9700	11193	8811	7473	8074
13	2668	3673	2317	3633	3028	5023	4696	6324	7098	5978	5034	4647
14	2486	2433	3151	3591	2830	4174	4105	4377	5126	4496	4223	3328
15	1601	1746	2217	2308	2124	1773	2959	3615	2558	2955	3851	2920
16	1387	1408	1320	1296	1350	2054	1626	2501	2075	1586	2176	1753
17	931	581	942	623	607	1270	1037	1314	1230	1051	1236	898
18	293	775	771	620	563	556	933	1110	615	609	834	447
19	236	303	480	395	536	618	390	283	330	296	315	360

	1972	1973	1974	1975	1976	1977	1978	1979	1980
6	2199	837	5222	2945	3400	6537	3538	6069	2924
7	2023	4909	7305	6693	7388	8065	7874	12560	9110
8	6576	8158	8070	8266	15963	10827	9238	16872	11601
9	9656	10096	6675	7802	15166	12653	11583	13242	13571
10	10907	7789	7741	6445	10772	10303	12370	11329	13735
11	10866	7741	5901	4524	6867	5954	8859	8075	10796
12	9147	5245	3839	3880	4273	3750	5825	3406	7696
13	5796	5111	2940	3110	2415	2014	2977	1640	3385
14	3720	2896	1642	2175	1984	1311	1738	594	1460
15	2151	1560	866	1091	1176	872	1161	294	619
16	1806	1828	595	595	448	308	469	148	244
17	1239	802	187	393	193	161	152	57	79
18	527	913	65	190	45	93	53	13	25
19	286	337	20	80	20	25	18	5	2

Table 10.

CATCH BIOMASS (KG)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
6	60	36	76	218	510	879	1424	639	523	603	541	405	611
7	224	140	174	517	1762	2544	3035	2764	1165	2216	764	2490	753
8	481	433	401	513	1490	4464	4552	2389	3561	4953	3599	3779	3183
9	821	1146	595	757	3151	4243	4991	3861	5457	8691	6574	6851	5089
10	1313	1784	981	1295	5227	5121	4692	7197	6555	7256	6953	7754	6861
11	1711	1724	1726	2116	4935	4566	5683	7713	5323	8473	8052	7591	8182
12	2886	1854	2296	3289	4882	4847	4588	9991	11092	8652	6285	7339	7930
13	2409	3262	2097	3150	2786	4681	4621	6729	7630	6277	5250	4805	5419
14	2966	2917	3800	4137	3419	5251	5283	5992	7161	6299	4924	3767	4371
15	2020	2207	2820	2897	2738	2441	4181	5896	4085	4734	5049	3735	2968
16	1814	1864	1756	1997	2155	3315	2693	4727	3903	2966	3640	2805	2987
17	1314	827	1340	1166	1166	2419	1993	2846	2702	2354	2292	1716	2297
18	444	1175	1176	1172	1089	1080	1789	2559	1413	1430	1729	946	1009
19	369	472	755	775	1070	1209	790	715	821	768	719	823	609

	1973	1974	1975	1976	1977	1978	1979	1980
6	204	1316	730	887	1726	941	1942	959
7	1433	2476	2322	2549	2895	2858	4697	3735
8	3100	3357	3455	6433	4666	3825	7559	5603
9	5240	3791	4510	8311	7883	5965	7230	7288
10	4899	5372	4550	7088	6965	7645	6729	7829
11	6317	5411	4171	5775	5263	6848	5515	7050
12	5460	4254	4264	4397	3799	5406	3086	5710
13	6353	3998	4164	2782	2415	3569	1948	3348
14	3863	2573	3341	2633	1821	2414	985	1974
15	2377	1664	1978	1950	1542	2053	554	1076
16	3320	1420	1380	957	676	1030	313	432
17	1555	460	1013	447	374	353	131	169
18	1921	187	547	122	237	135	42	67
19	773	60	235	57	77	55	16	6

POPULATION NUMBERS

Table 11.

	1960	1961	1962	1963	1964	1965	1966	1967	1968
6	177586	204804	198498	184840	182608	182434	191497	170416	153198
7	123641	145116	167509	162130	150467	147892	146618	152144	137513
8	108228	100491	118358	136574	131169	118983	114794	112619	118053
9	76723	87414	81227	95952	110610	104652	89330	85758	87608
10	49714	61294	69470	65474	77256	85361	79557	66105	64502
11	42613	38708	47481	55428	51723	55878	63318	59765	45894
12	32563	32667	29592	36763	42769	36496	40771	46590	40730
13	20908	23625	24812	21888	26591	29848	24857	29195	29420
14	17360	14714	16035	18225	14650	19042	19915	16126	18216
15	12950	11974	9856	10293	11691	9448	11837	12613	9272
16	7878	9160	8231	6076	6352	7660	6140	7032	7081
17	6351	5201	6232	5550	3809	3987	4427	3566	3517
18	3594	4361	3735	4254	3982	2572	2125	2692	1743
19	2732	2679	2873	2364	2924	2753	1606	906	1211
6+	682839	742207	783907	805812	816601	807005	796790	765526	717958
7+	505253	537403	585409	620972	633993	624572	605293	595110	564760
8+	381613	392287	417901	458842	483526	476680	458675	442966	427248
9+	273385	291796	299542	322268	352357	357697	343881	330346	309195

	1969	1970	1971	1972	1973	1974	1975	1976	1977
6	120548	119218	113435	141169	176935	252416	242083	260494	286327
7	123717	96819	95830	91459	113594	144106	201945	195541	210204
8	109564	95269	77180	71673	73054	88572	111392	159296	153427
9	89514	78866	69825	54760	52751	52458	65239	83743	116029
10	63555	59417	53526	44691	36142	34104	36934	46382	54914
11	44339	42285	39442	32435	26788	22586	20963	24438	28291
12	31940	26602	25518	23457	16814	14984	13191	13095	13843
13	23296	18238	15071	13650	11018	9061	8819	7318	6889
14	17708	13703	10412	8170	5993	4457	4782	4433	3826
15	10312	10458	7430	5540	3366	2323	2178	1972	1857
16	5294	5790	5113	3470	2610	1363	1126	811	570
17	3935	2911	2792	2615	1232	523	584	392	265
18	1777	2278	1278	1480	1035	298	260	131	149
19	876	909	1118	646	740	55	186	46	67
6+	646376	572764	517969	495215	522072	627306	709683	798092	876657
7+	525828	453546	404535	354046	345137	374890	467600	537598	590330
8+	402110	356727	308704	262587	231544	230784	265655	342057	380127
9+	292546	261458	231525	190914	158490	142212	154263	182761	226700

	1978	1979	1980
6	242333	285485	270407
7	228522	195210	228256
8	164820	179990	148493
9	115848	126607	132150
10	83591	84405	91720
11	35688	57297	58899
12	17808	21259	39637
13	7966	9357	14338
14	3833	3856	6184
15	1957	1586	2622
16	742	571	1034
17	193	192	335
18	74	24	106
19	39	14	8
6+	903414	965853	994187
7+	661081	680367	723780
8+	432559	485157	495525
9+	267739	305168	347032

MEAN POPULATION BIOMASS (KG)

Table 12.

	1960	1961	1962	1963	1964	1965	1966	1967	1968
6	31035	35066	31807	37924	46922	47360	47385	44019	38070
7	30597	36628	41818	43393	50694	47685	47554	51467	42807
8	35374	33763	40570	47284	57649	51518	49686	46708	46407
9	33467	38503	38141	45290	53300	57207	49367	45522	45114
10	26125	32240	37995	36222	42168	51876	54521	43644	37493
11	26007	25154	30918	35691	33187	39637	53218	42046	32761
12	23872	24704	22609	26536	30569	26335	34246	38470	30925
13	15920	17392	19321	15630	20798	22878	19855	24765	24801
14	17299	14536	15621	16954	14326	19065	20575	16954	19406
15	13814	12622	9940	10247	12289	10569	13038	15629	11336
16	8433	10065	9047	7482	8104	9517	7845	9588	10073
17	7469	6300	7371	8841	6052	5636	6704	5516	5599
18	4721	5405	4571	6708	6441	3986	2741	4274	2895
19	3686	3549	3717	3818	4757	4274	2548	1707	2313
6+	277819	295926	313447	342019	387258	397541	409281	390309	349998
7+	246784	260861	281640	304095	340335	350182	361895	346290	311928
8+	216187	224233	239822	260702	289642	302496	314342	294823	269121
9+	180813	190470	199252	213418	231993	250979	264656	248115	222714

	1969	1970	1971	1972	1973	1974	1975	1976	1977
6	31393	29452	26432	35273	39030	57013	54060	61192	67674
7	36146	28587	27528	30471	29365	43069	62383	59904	66987
8	38471	32510	26393	29877	23632	31746	40509	55018	57650
9	41421	35043	27825	23614	22188	25130	31949	37438	61630
10	34974	33150	25768	22002	18137	18740	21362	24079	30158
11	27254	26393	23747	17903	16579	16020	15417	15677	20020
12	24013	17067	17243	14272	13055	12886	10954	9942	10773
13	18981	14562	11653	8698	9011	9105	8539	6203	6250
14	19287	11950	8741	6365	5166	4988	4873	3929	3872
15	12551	9793	6652	5372	3377	3177	2509	1874	2149
16	7451	6876	5961	3574	2357	2194	1614	1043	765
17	6790	3678	3950	3161	1276	925	780	582	348
18	3040	3378	1961	2045	704	682	355	258	210
19	1663	1508	1891	923	1125	119	370	88	145
6+	303434	253948	215747	203551	185002	225795	255674	277227	328631
7+	272041	224496	189315	168277	145972	168781	201614	216036	260957
8+	235895	195908	161786	137806	116607	125712	139231	156132	193970
9+	197424	163398	135393	107929	92975	93966	98722	101114	136320

	1978	1979	1980
6	57968	81857	79923
7	73795	63875	83002
8	59978	69368	62259
9	51139	59092	60730
10	43024	42108	43494
11	21531	32733	31332
12	12187	15920	23793
13	6792	9102	11159
14	3536	5308	6580
15	1990	2433	3588
16	893	937	1440
17	190	333	564
18	92	48	225
19	80	32	20
6+	333193	383147	408109
7+	275225	301290	328186
8+	201430	237415	245184
9+	141452	168047	182925

Table 13.

FISHING MORTALITY

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
6	0.002	0.001	0.002	0.006	0.011	0.019	0.030	0.015	0.014	0.019	0.018	0.015
7	0.007	0.004	0.004	0.012	0.035	0.053	0.064	0.054	0.027	0.061	0.027	0.090
8	0.014	0.013	0.010	0.011	0.026	0.087	0.092	0.051	0.077	0.129	0.111	0.143
9	0.025	0.030	0.016	0.017	0.059	0.074	0.101	0.085	0.121	0.210	0.188	0.246
10	0.050	0.055	0.026	0.036	0.124	0.099	0.086	0.165	0.175	0.207	0.210	0.301
11	0.066	0.069	0.056	0.059	0.149	0.115	0.107	0.183	0.162	0.311	0.305	0.320
12	0.121	0.075	0.102	0.124	0.160	0.184	0.134	0.260	0.359	0.360	0.368	0.426
13	0.151	0.188	0.109	0.202	0.134	0.205	0.233	0.272	0.308	0.331	0.361	0.412
14	0.171	0.201	0.243	0.244	0.239	0.275	0.257	0.353	0.369	0.327	0.412	0.431
15	0.146	0.175	0.284	0.283	0.223	0.231	0.321	0.377	0.360	0.377	0.516	0.561
16	0.215	0.185	0.194	0.267	0.266	0.348	0.343	0.493	0.387	0.398	0.529	0.471
17	0.176	0.131	0.182	0.132	0.193	0.429	0.297	0.516	0.483	0.347	0.623	0.434
18	0.094	0.217	0.257	0.175	0.169	0.271	0.653	0.599	0.488	0.470	0.512	0.482
19	0.100	0.133	0.203	0.203	0.225	0.283	0.310	0.419	0.355	0.462	0.477	0.435
6+	0.037	0.035	0.032	0.039	0.067	0.087	0.093	0.109	0.117	0.160	0.156	0.189

	1972	1973	1974	1975	1976	1977	1978	1979	1980
6	0.017	0.005	0.023	0.014	0.015	0.026	0.016	0.024	0.012
7	0.025	0.049	0.057	0.037	0.043	0.043	0.039	0.074	0.045
8	0.107	0.131	0.106	0.085	0.117	0.081	0.064	0.109	0.090
9	0.215	0.236	0.151	0.141	0.222	0.128	0.117	0.122	0.120
10	0.312	0.270	0.287	0.213	0.294	0.231	0.178	0.160	0.180
11	0.457	0.381	0.338	0.271	0.368	0.263	0.318	0.168	0.225
12	0.556	0.418	0.330	0.389	0.442	0.353	0.444	0.194	0.240
13	0.623	0.705	0.439	0.488	0.449	0.386	0.526	0.214	0.300
14	0.687	0.748	0.516	0.686	0.670	0.470	0.683	0.186	0.300
15	0.553	0.704	0.524	0.788	1.041	0.717	1.032	0.228	0.300
16	0.836	1.408	0.647	0.855	0.918	0.885	1.153	0.335	0.300
17	0.727	1.219	0.497	1.298	0.768	1.075	1.863	0.394	0.300
18	0.494	2.729	0.274	1.540	0.474	1.129	1.473	0.862	0.300
19	0.660	0.687	0.503	0.636	0.650	0.529	0.690	0.500	0.300
6+	0.180	0.151	0.100	0.084	0.109	0.086	0.090	0.090	0.090

Table 14.

WEIGHTED FISHING MORTALITIES - 9-15

1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
0.0627	0.0647	0.0553	0.0616	0.0973	0.1229	0.1272	0.1636	0.1817	0.2319

1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
0.2365	0.2826	0.3204	0.3105	0.2096	0.1838	0.2195	0.1553	0.1578	0.1355

1980
0.1531

Table 15. MEAN BIOMASS 9-18, 9-19 10-18.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
8+	298223	311794	293116	266808	234233	194400	159895	136883	115482
9+	246705	262108	246408	220401	195762	161891	133502	107006	91850
10+	189498	212742	200886	175288	154341	126847	105677	83393	69662

	1974	1975	1976	1977	1978	1979	1980
8+	125593	138861	156044	193825	201350	237383	245164
9+	93847	98352	101026	136175	141372	168014	182905
10+	68717	66402	63587	74545	90233	108922	122175

Table 16. POPULATION BIOMASS (AVERAGE) POPULATION NUMBERS

	1980	1981	1982	1980	1981	1982
6	79922.59	79237.26	79271.53	270407	268018	268018
7	83002.40	79623.36	79090.31	228256	218750	216935
8	62258.87	75051.26	72303.57	148493	178657	171566
9	60730.35	51193.77	62108.01	132150	111112	134229
10	43494.36	45679.50	38861.35	91720	95961	81123
11	31332.68	33525.87	35641.23	58899	62724	66161
12	23793.46	23231.66	25202.94	39637	38506	41427
13	11158.98	19992.04	19837.80	14338	25528	25071
14	6579.36	9310.33	16977.50	6184	8696	15695
15	3588.18	5164.93	7439.17	2622	3751	5347
16	1440.34	2229.00	3265.68	1034	1590	2306
17	564.26	1062.93	1674.12	335	627	978
18	225.26	434.59	833.09	106	203	386
19	18.71	152.78	299.97	8	64	125
6+	408109.80	425889.26	442806.26	994189	1014188	1029365
7+	328187.21	346652.00	363534.73	723782	746170	761347
8+	245184.81	267028.64	284444.42	495526	527420	544412
9+	182925.94	191977.39	212140.85	347033	348763	372847

CATCH BIOMASS CATCH NUMBERS FISHING MORTALITY

	1980	1981	1982		1980	1981	1982		1980	1981	1982
6	959	908	837	6	2924	2768	2552	6	0.012	0.011	0.011
7	3735	3421	3132	7	9110	8343	7639	7	0.045	0.043	0.040
8	5603	6449	5726	8	11601	13351	11856	8	0.090	0.086	0.079
9	7288	5865	6559	9	13571	10922	12213	9	0.120	0.115	0.106
10	7829	7850	6156	10	13735	13772	10799	10	0.180	0.172	0.158
11	7050	7202	7057	11	10796	11029	10807	11	0.225	0.215	0.198
12	5710	5323	5323	12	7696	7174	7174	12	0.240	0.229	0.211
13	3348	5726	5237	13	3385	5790	5295	13	0.300	0.286	0.264
14	1974	2667	4482	14	1460	1972	3315	14	0.300	0.286	0.264
15	1076	1479	1964	15	619	851	1129	15	0.300	0.286	0.264
16	432	638	862	16	244	361	487	16	0.300	0.286	0.264
17	169	304	442	17	79	142	207	17	0.300	0.286	0.264
18	67	124	220	18	25	46	81	18	0.300	0.286	0.264
19	6	44	79	19	2	15	26	19	0.321	0.286	0.264
6+	45247	48000	48076	6+	75247	76535	73582	6+	0.090	0.090	0.085
7+	44288	47092	47239	7+	72323	73767	71030				
8+	40553	43671	44107	8+	63213	65424	63391				
9+	34949	37223	38380	9+	51612	52073	51535				

Table 17. Estimated population numbers from research vessel surveys in Division 3L and 3N for fish at ages 4, 5, 6 - millions of fish.

	Age 4			Age 5			Age 6		
Year	3L	3N	Total	3L	3N	Total	3L	3N	Total
1971	12.13	3.73	15.86	49.03	3.71	51.74	65.90	2.02	67.92
1972	13.17	2.73	15.90	27.60	3.70	31.30	51.73	5.05	83.03
1973	-	0.98	-	-	4.73	-	-	5.39	-
1974	4.38	3.16	7.54	6.78	4.68	11.46	23.74	7.42	31.16
1975	3.38	5.00	8.38	9.00	2.95	11.95	24.94	2.00	36.89
1976	15.65	-	-	16.62	-	-	18.18	-	-
1977	13.38	7.14	20.52	43.43	11.65	55.08	85.78	15.31	101.09
1978	19.82	11.97	31.79	76.00	20.75	96.75	80.65	15.67	96.32
1979	17.00	2.65	19.65	55.55	9.62	65.17	87.86	13.42	101.28
1980	9.65	1.93	11.58	53.30	4.78	58.08	92.50	8.47	100.97

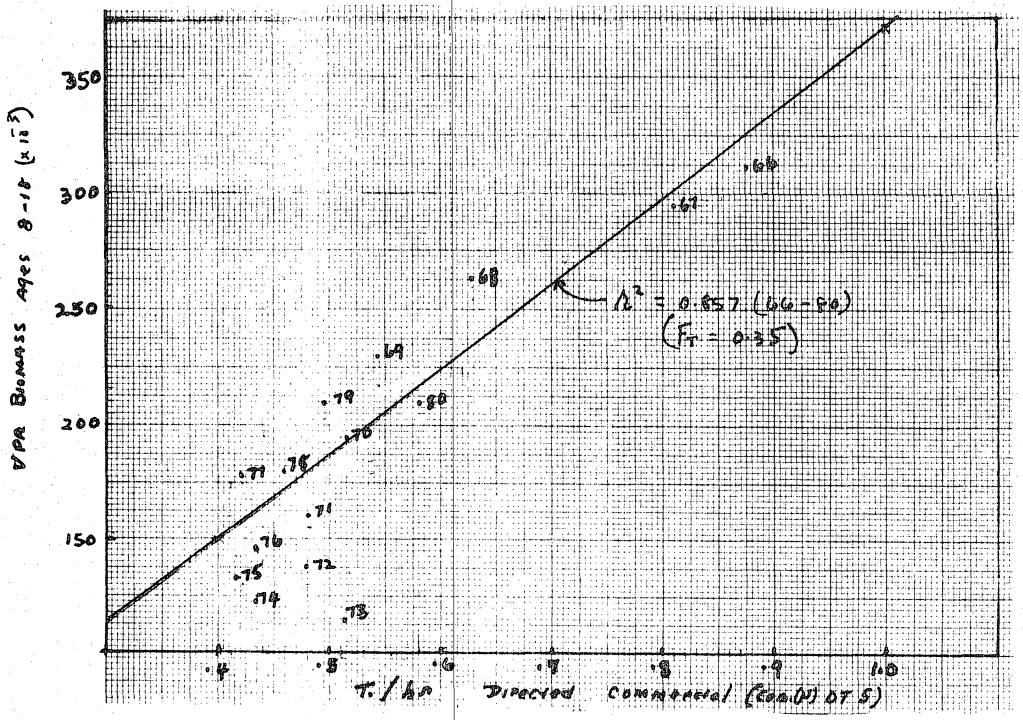

Fig. 1. Mean biomass on CPUE from directed fishery Can(N) OT-5 for VPA runs with Terminal F = 0.35. American plaice Divisions 3L and N.

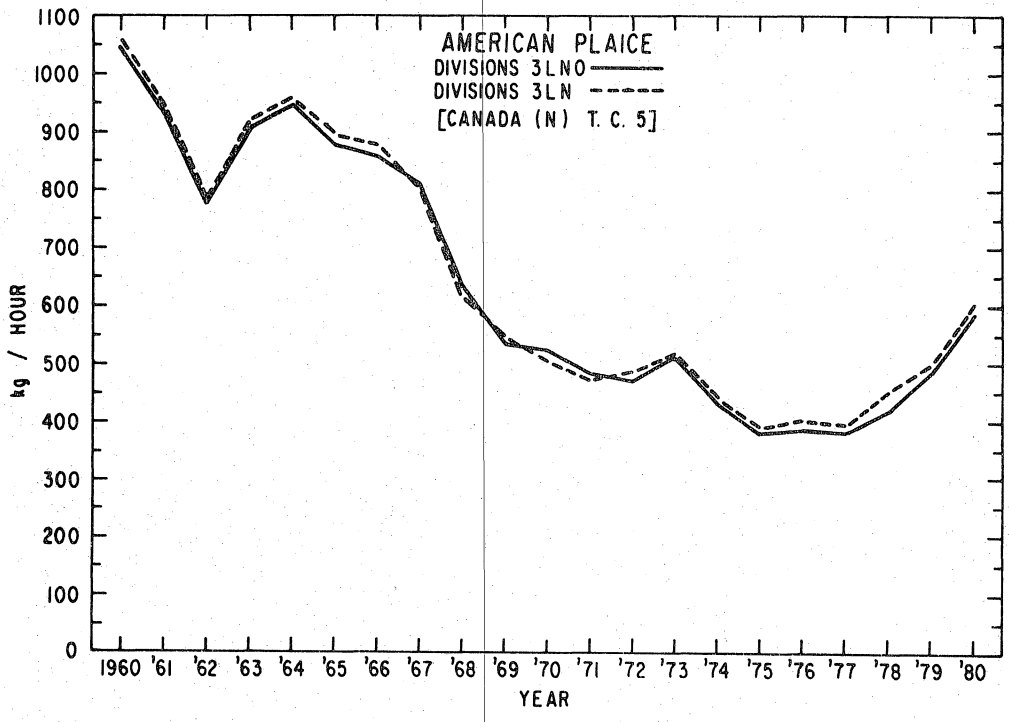

Fig. 2. Catch per hour for directed fishery for American plaice Can(N) OT-5. 1960-80 Divisions 3LN.

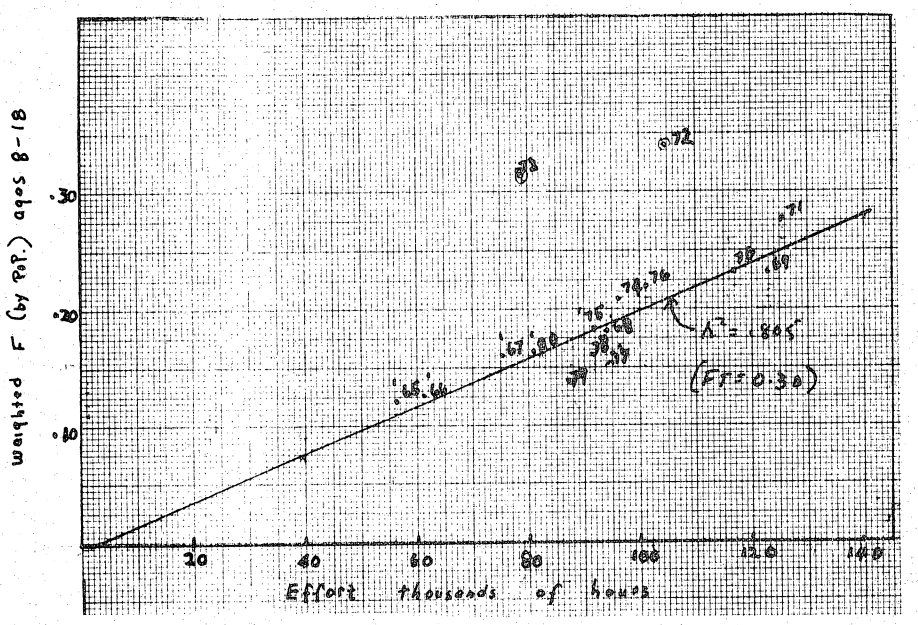

Fig. 3. Weighted F (ages 8-18) on directed fishing effort. American plaice 3LN. Points are for VPA at F_T = 0.30.

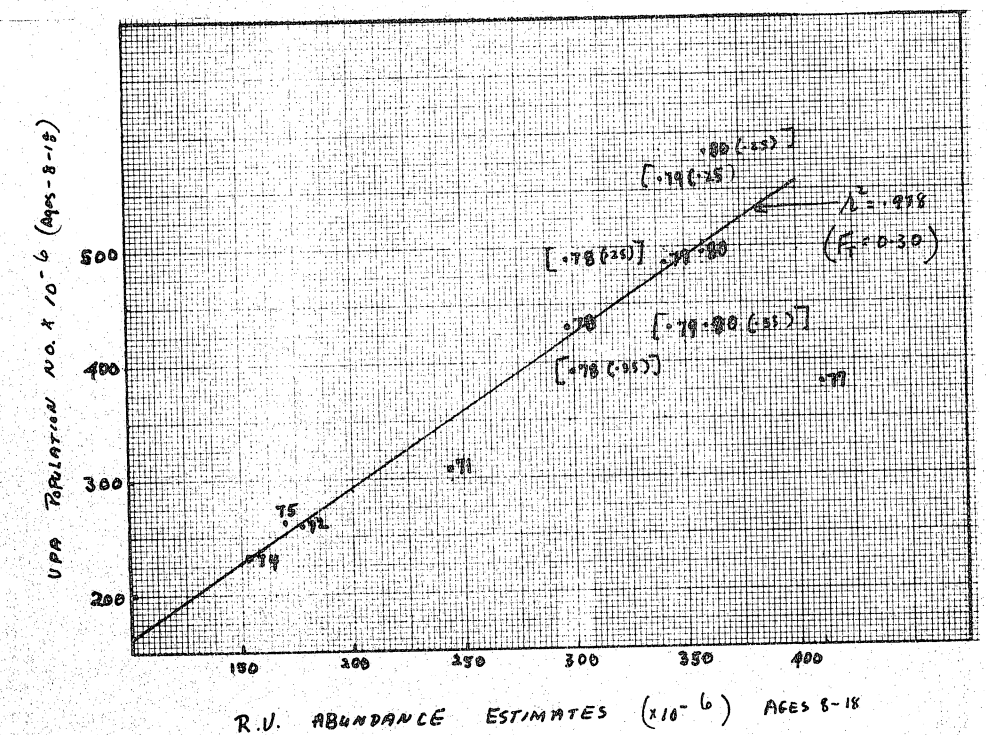

Fig. 4. Mean population numbers ages 8-18 from VPA runs with F_T = 0.3 on abundance estimates by research vessels.