Northwest Atlantic Fisheries Organization

Serial No. N166

NAFO SCR Doc. 80/VI/110
(Revised)

SCIENTIFIC COUNCIL MEETING - JUNE 1980

Assessment of American plaice on the Grand Bank

by

T. K. Pitt and W. B. Brodie
Department of Fisheries and Oceans
Northwest Atlantic Fisheries Center
P. O. Box 5667, St. John's, Nfld., Canada A1C 5X1

Introduction

Nominal catches from this stock since 1969, broken down by country, are given in Table 1 and by NAFO division in Table 2. TACs since 1973 are also listed in Table 1. It should be pointed out that catches given for the USSR prior to 1973 were calculated amounts from "Unspecified flatfish" catches as previously reported in the ICNAF Statistical Bulletins. As indicated in Table 2, most of the catch comes from Div. 3L and 3N. This is especially so in recent years.

Assessments of this stock have, in the past, been carried out separately for males and females. The reason for this was the fact that females reached greater ages than males and were significantly larger at age from about age 9. Most catches contain more females than males beyond about age 10 or 11. However, because of a general reduction in stock size, this difference is not as apparent in more recent years. But there is enough difference in the size at age between males and females (Fig. 1) to use separate age-length keys, as is done in the case of NAFO divisions (Fig. 2).

In this assessment, therefore, the number of males and females caught were determined from separate age-length keys and then combined to give total numbers at age (Table 3).

An assessment was done for Div. 3LN only and, for a final total TAC for Div. 3LNO, a quantity equivalent to the average catch from Div. 3O is added to the Div. 3LN projection to give a total stock TAC.

Sampling

Numbers at age (Table 3) were calculated from otolith and length frequency samples in the usual way. A listing of samples from the commercial fishery is listed in Table 4.

Average Weight at Age

Average weight at age was calculated from average lengths at age using the monthly samples weighted by the numbers caught at age. Average lengths were converted average weights by the length-weight equation.

Partial Recruitment Rates

Partial recruitment rates [Table 5(b)] were determined from a preliminary cohort run using numbers at age 1976-79. This run calculated average F's across years to give starting values for each cohort in 1979. The partial recruitment rates determined from these F values in 1979 were adjusted to give less emphasis to the high fishing mortality values at the older age-groups than in previous assessments.

Terminal F's for 1979 (F_{T})

Three different methods were attempted.

(a) Regression of F for fully recruited age-groups on directed effort (Fig. 3 and Table 6) for 1965-77. The VP run that gives the closest value to the input F_T for 1979 was the run at $F_T = 0.25$ (Table 6). The regression gave a predicted F for fully recruited ages of 0.27.

(b) Regression of biomass from VP on catch per hour from the directed Canada (N) OT5 plaice fishery. As Fig. 4 and Table 7 indicate, the 1965-67 values are comparatively low. This might be, in part,

caused by the use of the weight-at-age vector calculated from the 1979 sampling. However, both with all the data and omitting 1965-67, the virtual population run that gave the predicted value closest to the observed biomass was the run at $F_T = 0.3$.

(c) Regression of biomass (ages 7-18) on average catch per tow from survey data (Fig. 5) indicates that the virtual population run giving the value closest to the observed was the run initiated by $F_T = 0.35$. However, there are some difficulties with the survey data as Tables 8 and 9 indicate that surveys were incomplete in 1973 and 1976 and estimates had to be made for some of the usual strata. However, the two points do fall on the line for the $F_T = 0.35$ run.

Recruitment

Recruitment for this stock at age 6 used in the particular run presented here ($F_T = 0.27$) was 390 million fish (Tables 10 and 11). Attempts to correlate numbers caught in surveys at age 5 or 6 with population numbers in the virtual population were not successful, possibly because of high discard rates biasing the population estimates in the early ages.

Projections

Projections (Table 12) for illustrative purposes were made from the population in 1979 (Table 11) produced from the virtual population run using $F_T = 0.27$. Assuming that the 1980 TAC in Div. 3LN (estimated at 40,000 tons out of a total TAC for Div. 3LNO of 47,000 tons) is removed, the projected value for 1981 would be about 48,000 tons.

Listed below is a summary of projections to 1981, assuming average recruitment for the particular virtual population for Div. 3LN, $F_{0.1} = 0.23$ [Table 5(a)].

		1980		1981	
	Terminal F	Catch x 10^{-3} tons	F	Catch x 10^{-3} tons	F
(a)	0.27	40.0	0.23	47.7	0.23
(b)	0.30	40.0	0.26	42.2	0.23
(c)	0.35	40.0	0.32	37.2	0.23

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

Year	Canada	France	Poland	USSR	Other	Total	TAC
1966	51225	1246	860	11484	196	65011	
1967	54190	1326	3234	35139	524	94413	
1968	48674	406	203	23751	133	73167	
1969	64815	43	34	14493	52	79437	
1970	54929	389	40	10232	1055	66645	
1971	49394	323	370	17173	628	67888	
1972	41605	322	2515	14164	755	59361	
1973	38586	310	1116	12516	319	52843	60000
1974	35101	418	615	10074	89	46297	60000
1975	34015	442	537	7682	545	43221	60000
1976	47806	305	5	3280	429	51825	47000
1977	42579	31	0	1023	349	43982	47000
1978	48634	168	0	1048	178	50028	47000
1979*	47385	117		1014		48516	47000
1980							47000

* Provisional

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

Year	Div. 3L	Div. 3N	Div. 3Ø	Total
1965	25034	26270	1957	53279
1966	18572	34698	11741	65011
1967	38515	24364	31534	94413
1968	39126	20038	14003	73167
1969	52880	14442	12115	79437
1970	39347	21032	6266	66645
1971	37851	22873	7164	67888
1972	33330	17387	8644	59361
1973	20103	20883	11857	52843
1974	16609	21118	8561	46297
1975	15171	21308	6742	43221
1976	25112	18623	8080	51825
1977	23763	16543	3675	43981
1978	30145	13443	6440	50028
1979	28954	14801	4761	48516

Table 3.

CATCH MATRIX

AGE/YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
5	458.	1442.	289.	223.	585.	105.	1016.	494.	36.	343.
6	3042.	5153.	2469.	460.	578.	1968.	1565.	1899.	837.	5222.
7	6969.	8341.	7810.	4123.	7398.	2315.	7524.	2023.	4909.	7305.
8	8964.	9560.	5449.	9245.	12500.	9066.	9354.	6576.	8158.	8070.
9	6789.	7992.	6708.	10599.	16641.	12464.	13868.	9656.	10096.	6675.
10	6285.	6118.	9508.	10437.	11518.	10225.	13670.	10970.	7789.	7741.
11	5521.	6032.	9419.	6914.	10006.	10128.	9833.	10866.	5666.	5901.
12	5578.	4933.	10043.	10563.	9099.	7473.	8074.	9148.	5245.	3839.
13	5023.	5064.	6787.	7703.	5726.	5036.	4647.	5796.	5111.	2940.
14	4174.	4437.	4429.	5166.	3601.	4223.	3628.	3720.	3896.	1801.
15	1773.	3185.	3700.	2630.	2853.	3851.	3420.	2151.	1560.	865.
16	2221.	1990.	2788.	2415.	1619.	2176.	2153.	1806.	1828.	595.
17	1270.	1136.	1369.	1277.	1088.	1236.	928.	1239.	802.	187.
18	556.	1032.	1125.	653.	633.	834.	507.	527.	913.	65.
19	618.	426.	383.	363.	310.	435.	360.	386.	337.	20.
20	466.	262.	344.	302.	138.	64.	123.	321.	107.	4.

AGE/YEAR	1975	1976	1977	1978	1979
5	793.	811.	965.	1225.	1243.
6	2945.	3400.	6537.	3538.	6036.
7	6693.	7388.	8065.	7874.	11726.
8	8266.	15963.	10827.	9238.	15782.
9	7802.	15166.	12653.	11583.	14021.
10	6445.	10772.	9303.	12370.	13229.
11	4524.	6867.	5954.	8859.	9119.
12	3880.	4273.	3750.	5825.	3763.
13	3110.	2415.	2308.	2977.	1805.
14	2175.	1984.	1311.	1738.	704.
15	1090.	1176.	872.	1161.	336.
16	595.	448.	308.	470.	173.
17	393.	193.	161.	152.	64.
18	190.	45.	93.	53.	13.
19	80.	20.	25.	18.	4.
20	35.	7.	19.	4.	1.

AGE	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
RFC	.01	.07	.14	.25	.34	.50	.61	.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 4. List of samples for plaice in Division 3LNO during 1979

Div.	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
	Otoliths	Measured	Otoliths	Measured	Otoliths	Measured	Otoliths	Measured
3L	674	4936	678	5658	802	12,279	657	7031
3N	102	329	503	1711	884	9173	695	5678
3O	112	507	258	1223	378	2163	511	2759

TABLE 5

SUMMARY OF YIELD PER RECRUIT CALCULATED FROM
PARTIAL RECRUITMENT AND AVERAGE WEIGHT AT AGE
OVER AGES 6 TO 20

(a)

F	Y/R(KG)
.001	.0022
.050	.0881
.100	.1411
.150	.1731
.200	.1926
.250	.2047
.300	.2122
.350	.2171
.400	.2204
.450	.2228
.500	.2246
.550	.2261
.600	.2273
.650	.2285
.700	.2295
.750	.2305
.800	.2315
.850	.2324
.900	.2333
.950	.2341
1.000	.2350
1.050	.2358
1.100	.2366
1.150	.2374
1.200	.2381
1.250	.2389
1.300	.2396
1.350	.2402
1.400	.2409
1.450	.2415
1.500	.2422
1.550	.2428
1.600	.2433
1.650	.2439
1.700	.2444
1.750	.2450
1.800	.2455
1.850	.2459
1.900	.2464
1.950	.2469
2.000	.2473

F0.1 IS .2320

(b)

AGE	MEAN WEIGHT	PROPORTION RECRUITED
6	300.00	.070
7	350.00	.140
8	400.00	.250
9	495.00	.340
10	537.00	.500
11	625.00	.610
12	725.00	.750
13	936.00	1.000
14	1192.00	1.000
15	1650.00	1.000
16	1575.00	1.000
17	2135.00	1.000
18	3185.00	1.000
19	2614.00	1.000
20	2614.00	1.000

NATURAL MORTALITY RATE IS .200

Table 6. Fishing mortality on directed effort plaice 3LNO (F_T = terminal F)

Year	Directed Effort hrs. X 10^{-3}	Total F from V.P. Ages 10-19 F_T = 0.20	0.25	0.30
1965	56.1	.155	.155	.155
1986	60.8	.152	.152	.152
1967	76.8	.249	.249	.249
1968	94.6	.273	.273	.273
1969	123.2	.307	.307	.307
1970	118.4	.315	.315	.315
1971	130.5	.375	.375	.375
1972	106.6	.473	.473	.473
1973	79.0	.414	.414	.414
1974	86.4	.329	.337	.342
1975	92.4	.308	.321	.330
1976	101.5	.348	.374	.394
1977	95.8	.233	.264	.290
1978	95.1			
1979	88.5			
	R^2	0.6937	0.6596	.6226
	a	0.0361	0.0407	.0440
	b	.0026	.0026	.0026
Predicted F 1979		0.262	0.269	0.274

* 1972 and 1973 omitted.

Table 7 Data for regression of biomass ages 9-18 on CPUE (directed) plaice 3LNO for three V.P. runs of the terminal F's (F_T) indicated.

Year	CPUE Directed kg/hr	Biomass from V.P. 'Tons X 10^{-3} F_T=0.25	0.30	0.35
1965	914	201.8	201.8	201.8
1966	875	206.0	206.0	206.0
1967	818	200.2	200.2	200.2
1968	625	180.2	180.2	180.2
1969	546	166.6	166.6	166.6
1970	510	152.3	152.3	152.3
1971	465	131.3	131.1	131.1
1972	476	107.3	107.2	107.1
1973*	519	82.0	81.6	81.4
1974	437	66.2	65.0	65.0
1975	417	64.7	63.3	62.3
1976	431	68.0	63.4	63.5
1977	413	75.6	70.0	66.2
1978	458	108.7	96.2	87.3
1979	508	179.9	123.4	100.4
65-77	R^2	.7764	.7705	.7671
	a	-19.716	-23.8380	-24.6419
	b	0.2681	0.2733	8.2738
Calc. Biomass	1979	116.5	115.0	114.5
65-78	R	.7796	.7777	.7746
	a	-18.3930	-25.0405	-27.7851
	b	0.2665	0.2747	.2775
Calc. Biomass	1979	116.9	114.5	113.2
68-77	R^2	0.8496	0.8479	0.8516
	a	-180.8803	-191.0451	-195.8705
	b	0.6111	0.6293	0.6382
Calc. Biomass	1979	129.0	128.6	128.4

Table 8 Average no and catch/set (weighted by area) for divisions 3L and 3N and 3LN from research vessel surveys.

Div.	1971	1972	1973	1974	1975	1976	1977	1978	1979	
Average number/set										
3L	274	207	155*	132	269	304	460	465	370	
3N	69	63	49	50	70	83*	102	151	97	69
3LN	209	161	121*	106	205	233*	346	365	283	
Average weight/set										
3L	115.1	78.3	46.7*	520	63.8	77.0	115.5	95.4		
3N	58.8	57.9	36.1	30.0	26.9	42.2*	48.6	55.5	38.9	35.1
3LN	97.2	71.8	43.3*	45.0	52.1	66.0*	94.3	82.7		

* Survey incomplete in Division

Table 9. Average No/Set at age from research vessel surveys, Divisions 3L & N

	1971	1972	1973 (3N)	1974	1975	1976 (3L)	1977	1978	1979
Male									
3	1.05	0.33	.20	0.30	1.04	2.75	1.42	5.51	
4	3.89	5.17	.56	2.26	2.09	3.77	5.00	6.09	4.21
5	12.24	6.39	3.22	2.85	3.57	6.16	15.86	25.52	15.11
6	15.97	13.77	4.11	8.39	9.47	6.03	25.04	26.44	25.83
7	20.28	15.26	3.44	9.70	11.55	18.34	35.79	30.37	24.17
8	7.45	11.26	2.44	10.28	18.38	32.58	42.08	23.55	25.71
9	14.37	7.05	2.02	8.17	19.94	27.10	19.30	13.96	17.08
10	8.59	8.99	2.79	8.02	7.88	23.51	15.77	10.91	15.61
11	7.24	4.84	3.96	4.21	3.38	13.34	7.44	3.67	6.53
12	6.00	4.63	1.44	2.44	1.92	6.65	5.47	2.49	1.59
13	3.51	1.31	0.68	1.76	0.55	2.48	1.29	0.93	0.43
14	1.50	0.27	0.05	0.40	0.23	0.04	0.27	0.19	0.01
15	0.09	0.09		0.14	0.06	0.82	0	0.09	0
16	0.08	0.05				0.52			
FEMALE			(3N)			(3L)			
3	1.17	0.18	0.12	0.34	1.04	2.65	1.25	5.54	0.35
4	3.27	5.04	0.68	2.17	1.99	4.77	4.44	7.08	5.09
5	11.93	9.94	2.85	2.62	3.37	5.02	15.49	25.44	15.63
6	15.50	12.23	2.18	8.50	7.86	5.92	24.93	25.76	36.34
7	21.58	10.70	3.31	7.30	12.66	17.80	33.38	26.76	22.48
8	10.30	9.09	2.46	7.37	13.71	23.78	33.06	30.41	27.33
9	15.43	6.10	1.30	5.58	10.49	26.13	23.92	24.65	20.87
10	5.99	5.89	2.13	6.15	13.29	22.82	24.16	16.05	14.60
11	5.97	4.33	1.82	3.02	7.77	14.73	9.52	5.55	9.73
12	6.22	4.22	2.62	3.88	5.62	9.74	5.56	3.77	5.41
13	5.56	3.01	2.24	2.13	3.02	4.81	3.42	1.98	2.05
14	5.22	3.14	0.80	1.61	1.65	1.94	1.75	1.63	1.39
15	3.48	2.89	0.72	1.15	0.79	0.82	1.36	0.80	0.94
16	2.66	1.95	0.53	0.44	0.70	0.52	0.76	0.38	0.46
17	1.90	0.75		0.11	0.52		0.46	0.24	0.17
18									0.03

TABLE 10

3LN PLAICE M+F
FISHING MORTALITIES

AGE/YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
5	.002	.007	.002	.002	.004	.001	.007	.002	.000	.001
6	.018	.029	.016	.003	.005	.018	.016	.015	.005	.021
7	.053	.061	.056	.033	.070	.026	.090	.025	.050	.057
8	.084	.096	.052	.087	.131	.115	.141	.105	.135	.109
9	.074	.100	.090	.134	.223	.186	.258	.211	.233	.156
10	.084	.089	.165	.196	.211	.208	.320	.334	.264	.282
11	.117	.109	.191	.174	.293	.290	.316	.454	.288	.327
12	.181	.145	.265	.339	.363	.371	.396	.547	.414	.323
13	.199	.247	.304	.334	.311	.351	.416	.553	.685	.433
14	.265	.270	.356	.401	.257	.397	.461	.698	.922	.552
15	.238	.332	.379	.370	.404	.481	.654	.550	.728	.534
16	.429	.457	.543	.457	.411	.621	.547	.901	1.392	.692
17	.382	.408	.663	.518	.384	.639	.596	.713	1.536	.483
18	.343	.615	.926	.792	.528	.575	.595	.827	2.443	.457
19	.635	.480	.488	.919	1.191	.870	.527	1.372	3.532	.343
20	.635	.615	.926	.919	1.191	.870	.654	1.372	3.532	.692

AGE/YEAR	1975	1976	1977	1978	1979
5	.002	.002	.002	.003	.002
6	.011	.011	.018	.009	.019
7	.034	.033	.032	.026	.038
8	.084	.106	.062	.046	.068
9	.146	.219	.114	.087	.092
10	.222	.308	.203	.156	.135
11	.265	.389	.279	.302	.165
12	.371	.428	.382	.484	.203
13	.471	.418	.435	.596	.270
14	.669	.630	.421	.691	.270
15	.782	.982	.638	.828	.270
16	.889	.902	.767	.879	.270
17	1.577	.839	1.025	1.173	.270
18	1.425	.784	1.453	1.260	.270
19	1.913	.530	1.600	1.486	.270
20	1.913	.982	1.600	1.486	.270

TABLE 11

POPULATION NUMBERS

AGE/YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
5	242222.	216286.	180556.	147625.	147663.	135070.	168264.	219028.	337501.	380126.
6	193117.	197899.	175777.	147565.	120664.	120367.	110491.	136845.	178877.	276290.
7	148863.	155364.	157373.	141684.	120400.	98269.	96771.	89049.	110324.	145696.
8	123063.	115587.	119674.	121797.	112278.	91900.	78365.	72443.	71081.	85894.
9	104666.	92668.	86013.	93062.	91379.	80659.	67069.	55730.	53384.	50843.
10	85726.	79568.	68663.	64371.	66640.	59838.	54812.	42438.	36936.	34623.
11	55059.	64516.	59626.	47651.	43304.	44191.	39786.	32592.	24889.	23233.
12	37156.	40102.	47385.	40335.	32783.	26459.	27076.	23738.	16942.	15283.
13	30671.	25396.	28387.	29760.	23534.	18669.	14954.	14922.	11246.	9166.
14	19704.	20588.	16237.	17142.	17445.	14122.	10761.	8074.	7029.	4642.
15	9207.	12377.	12865.	9315.	9399.	11044.	7772.	5558.	3289.	2288.
16	6974.	5943.	7272.	7212.	5266.	5135.	5591.	3307.	2625.	1300.
17	4390.	3718.	3081.	3458.	3739.	2859.	2259.	2650.	1100.	534.
18	2103.	2454.	2025.	1300.	1687.	2085.	1236.	1019.	1063.	194.
19	1436.	1222.	1086.	657.	482.	815.	961.	558.	365.	76.
20	1083.	623.	619.	546.	215.	120.	280.	464.	116.	9.

AGE/YEAR	1975	1976	1977	1978	1979
5	429211.	508198.	525823.	435678.	726293.
6	310911.	350689.	415345.	429632.	355594.
7	221492.	251892.	284048.	334153.	348556.
8	112692.	175293.	199561.	225277.	266472.
9	63050.	84807.	129131.	153616.	176100.
10	35613.	44590.	55784.	94318.	115321.
11	21386.	23357.	26826.	37296.	66076.
12	13719.	13439.	12960.	16610.	22573.
13	9063.	7749.	7171.	7244.	8379.
14	4867.	4633.	4178.	3801.	3268.
15	2189.	2042.	2020.	2245.	1560.
16	1099.	820.	627.	874.	803.
17	533.	370.	272.	238.	297.
18	270.	90.	131.	80.	60.
19	101.	53.	34.	25.	19.
20	44.	12.	26.	6.	5.

390,000

POPULATION BIOMASS AGES 6 TO 18

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
BIOMASS	412928.	411850.	398412.	368804.	335106.	299505.	262719.	236043.	229020.	259301.

YEAR	1975	1976	1977	1978	1979
BIOMASS	311152.	372273.	440899.	515157.	558432.

TABLE 12

CATCH PROJECTION FOR 1980 USING POPULATION ESTIMATES FROM COHORT WITH TERMINAL F OF .270

AGE	POPULATION NUMBERS (000S)	POPULATION WEIGHT (MT)	FISHING MORTALITY	CATCH NUMBERS (000S)	CATCH WEIGHT (MT)	RESIDUAL NUMBERS (000S)	RESIDUAL WEIGHT (MT)
6	390000.	117000.	.016	5650.	1695.	314203.	94261.
7	285685.	99990.	.032	8213.	2875.	226484.	79269.
8	274788.	109915.	.058	13936.	5575.	212400.	84960.
9	203928.	100944.	.078	13928.	6894.	154397.	76427.
10	131533.	70633.	.115	12981.	6971.	95986.	51544.
11	82494.	51559.	.140	9815.	6134.	58695.	36685.
12	45883.	33265.	.173	6611.	4793.	31611.	22918.
13	15093.	14127.	.230	2823.	2642.	9817.	9189.
14	5237.	6243.	.230	979.	1167.	3406.	4060.
15	2042.	3369.	.230	382.	630.	1328.	2192.
16	975.	1536.	.230	182.	287.	634.	999.
17	502.	1072.	.230	94.	200.	327.	697.
18	186.	592.	.230	35.	111.	121.	385.
19	38.	99.	.230	7.	19.	25.	65.
20	15.	39.	.230	3.	7.	10.	26.
TOTAL	1438399.	610384.		75638.	40000.	1109445.	463676.

CATCH PROJECTION FOR 1981 USING POPULATION ESTIMATES FROM COHORT WITH TERMINAL F OF .270

AGE	POPULATION NUMBERS (000S)	POPULATION WEIGHT (MT)	FISHING MORTALITY	CATCH NUMBERS (000S)	CATCH WEIGHT (MT)	RESIDUAL NUMBERS (000S)	RESIDUAL WEIGHT (MT)
6	390000.	117000.	.016	5647.	1694.	314205.	94262.
7	314203.	109971.	.032	9029.	3160.	249096.	87184.
8	226484.	90594.	.058	11481.	4592.	175068.	70027.
9	212400.	105138.	.078	14499.	7177.	160818.	79605.
10	154397.	82911.	.115	15231.	8179.	112677.	60508.
11	95986.	59991.	.140	11415.	7134.	68300.	42687.
12	58695.	42554.	.173	8453.	6128.	40442.	29320.
13	31611.	29588.	.230	5909.	5531.	20563.	19247.
14	9817.	11702.	.230	1835.	2188.	6386.	7612.
15	3406.	5620.	.230	637.	1051.	2216.	3656.
16	1328.	2092.	.230	248.	391.	864.	1361.
17	634.	1354.	.230	119.	253.	413.	881.
18	327.	1040.	.230	61.	194.	212.	677.
19	121.	316.	.230	23.	59.	79.	206.
20	34.	90.	.230	6.	17.	22.	59.
TOTAL	1499445.	659962.		84593.	47749.	1151361.	497291.

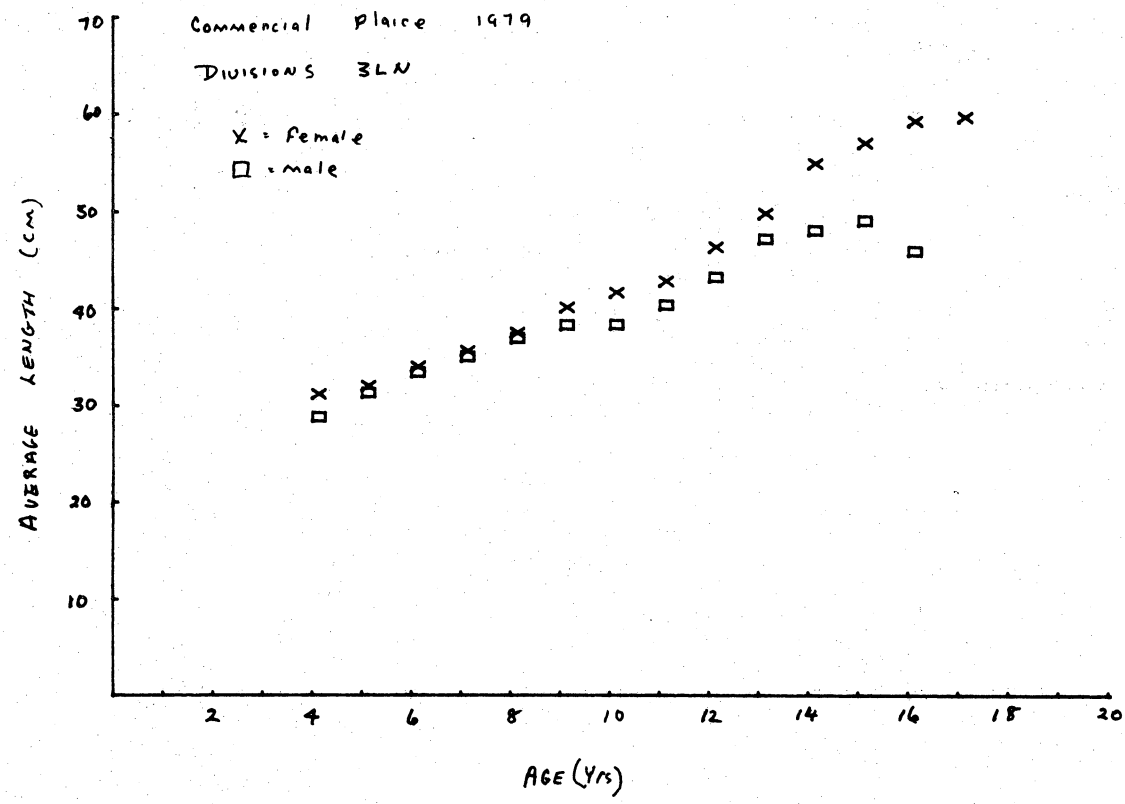

Fig. 1. Age-length plots comparing male and female length at age from Division 3L

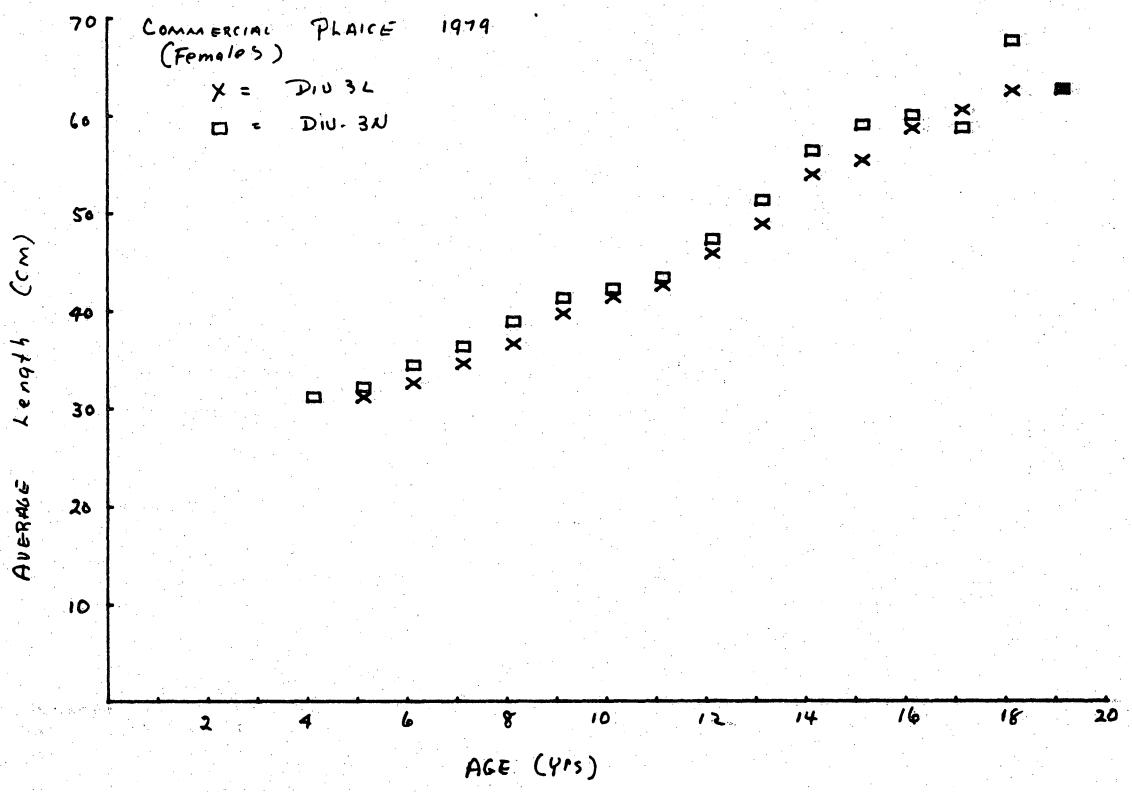

Fig. 2a Age-length plots for male American plaice in Divisions 3L and 3N

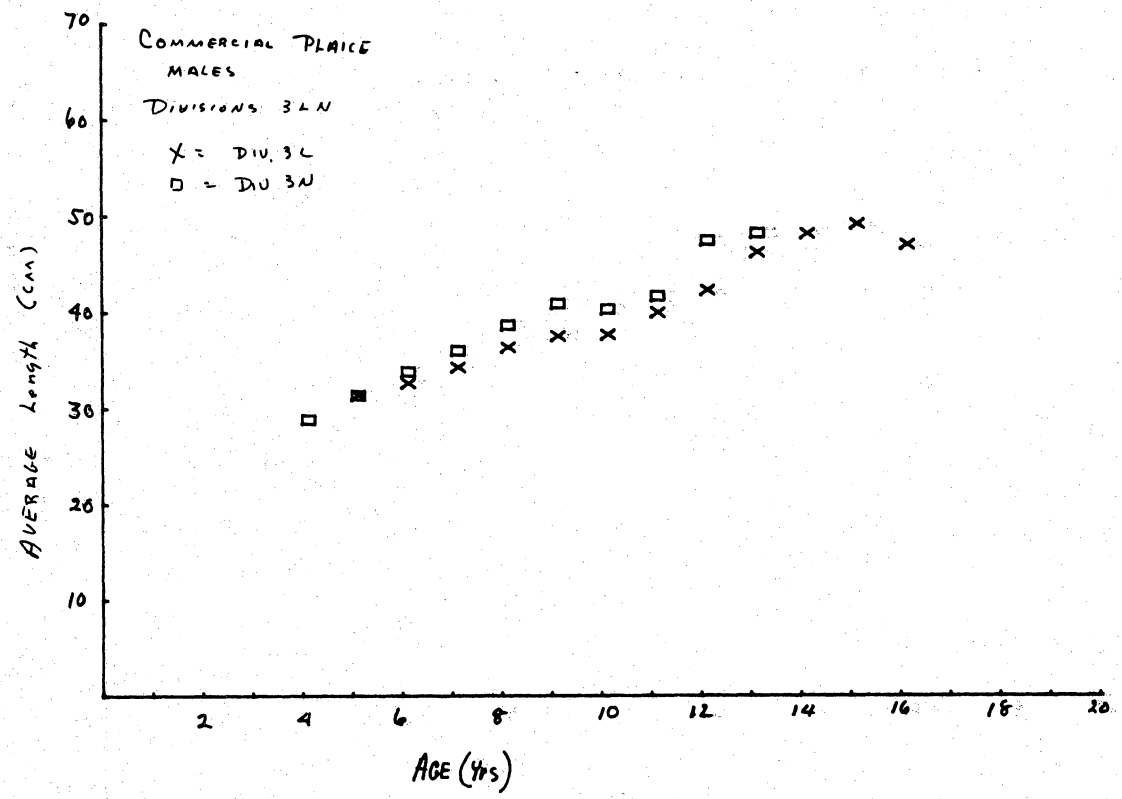

Fig. 2b Age-length plots for female American plaice in Divisions 3L and 3N

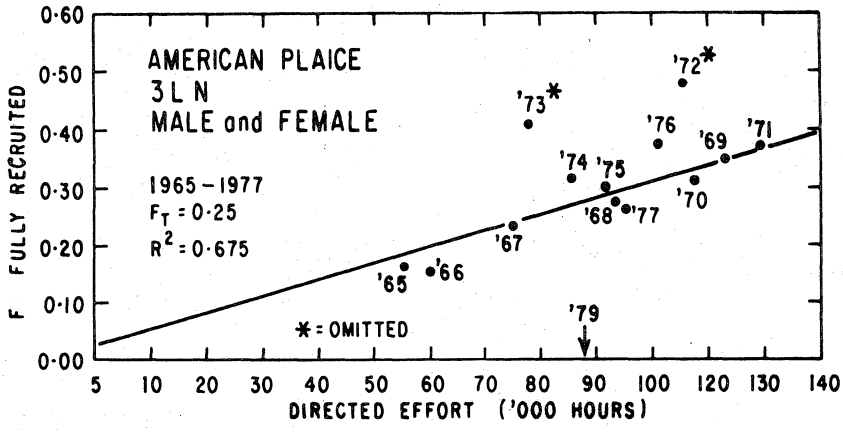

Fig. 3. Regression of fishing mortality (ages 9-19) calculated from population numbers on directed effort (see Table 4).

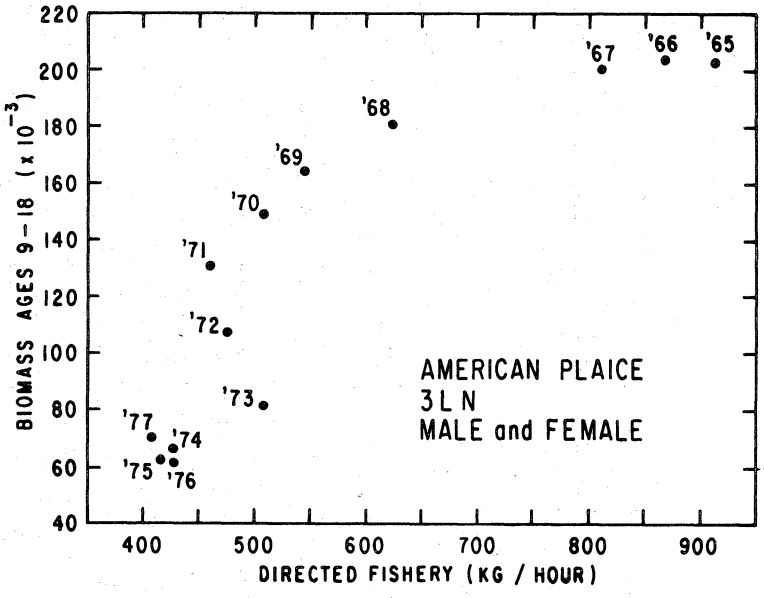

Fig. 4. Plot of biomass from V.P. on commercial directed CPUE (see Table 5).

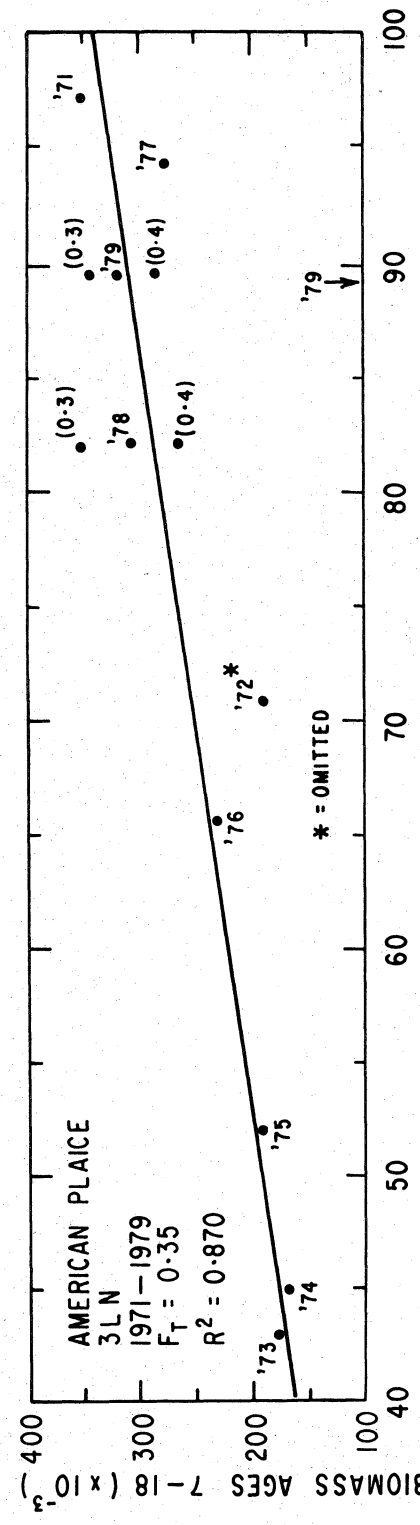

Fig. 5. Regression of biomass (ages 7-18) on survey catch per tow.