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American plaice in Subdivision 3Ps an assessment update

by

T.K. Pitt
Department of Fisheries and Oceans
Research and Resource Services
Northwest Atlantic Fisheries Center
P.O. Box 5667
St. John's, Newfoundland
A1C 5X1

Abstract

An analytical assessment update was attempted, however, there was difficulty arriving at precise assessment parameters. Partial recruitment was calculated by two methods (a) ratio of commercial to research vessel catches at age and (b) average Fs from cohort runs 1973-79. Using the two methods and the different terminal F's and $F_{0.1}$ associated with them indicated removal levels in 1981 of 9,000 using (a) to 5,000 using (b). Because of the uncertainty of the parameters, and because of the apparent stable condition of the stocks it appears prudent to leave the TAC for 1981 at 5,000 the average total catch since 1974.

Résumé

Nous avons tenté de mettre à jour une évaluation analytique, mais il a été difficile d'obtenir des paramètres d'évaluation précis. Le recrutement partiel a été calculé suivant deux méthodes: a) le rapport entre prises commerciales et prises des navires de recherche pour un âge donné et b) un Fs moyen établi à partir des groupes de cohortes de 1973-79. Ces deux méthodes et l'utilisation des F et $F_{0.1}$ terminaux différents qui leur sont associés indiquent des niveaux de prélèvement en 1981 de 9 000 t suivant a) et de 5 000 t suivant b). À cause de l'incertitude des paramètres et des conditions apparemment stables des stocks, il semble prudent de maintenir le TPA de 1981 à 5 000 t, soit au niveau des prises totales moyennes depuis 1974.

Introduction

This stock has been under quota regulation since 1973. Catches and TACs are listed in Table 1. The highest catch was recorded in 1968 when approximately 14,000 t were reported, however, there was some doubt concerning the species breakdown of the USSR from the "unspecified flatfish" category in the ICNAF statistical bulletins prior to 1973. Although there is a directed fishery, at least 30% of the catch is taken as a by-catch of other fisheries.

Assessment

Listed below are the otoliths and measurements available for this assessment collected by the commercial sampling group at St. John's for 1979.

Quarter	No. measured	Otoliths sampled
1	3733	545
4	1222	259

The numbers at age were calculated from these data and some details of these calculations are indicated in Table 2.

Numbers at age data from this stock are available since 1973, however, the 1973 and 1974 sampling was rather small and although analytical assessments have been attempted on this stock in the past, the results have been far from satisfactory and assessments have generally tried to relate probable fishing mortalities to average removals.

Nevertheless an analytical assessment (cohort analysis) was again attempted this year. Difficulty however, was encountered in arriving at precise parameters. Some details of the assessment are presented here for the record.

Partial recruitment was derived by two methods. Method (a) (Table 3) from the ratio of the number caught per thousand from commercial to research vessel data. The latter are plotted in Fig. 1 and 2; with the actual values derived from the eye fitted line shown in Table 3(a). The other method (Method (b) Table 3) derives partial recruitment rates from average F's produced by planning runs of the cohort and is similar to that used in the 1979 assessment (Pitt 1979).

Average weights at age (Table 3) were calculated from the available monthly average length at age data weighted by the calculated numbers caught at age to give average annual length at age. These were converted to weight at age using the following:

Whole weight (kg) = 3.324 log length - 5.5535

Terminal F (F_T) was derived from data using both methods of calculating partial recruitment. Biomass from cohorts on CPUE 1973-77 (Tables 4 and 5) and numbers from cohort on numbers caught by research vessel surveys (Tables 6 and 7) were used to predict F_T.

increases generally with age regardless of the input partial recruitment, hence the partial recruitment vector calculated from average Fs appears to be more realistic.

Because of the rather short series of data it was difficult to get a significant relationship from which to determine terminal F.

As indicated the population size at the beginning of 1979 was used to project forward to give the projected population at the beginning of 1980. The following text table gives a summary of the projections with the associated terminal F values and 1981 projected catch at $F_{0.1}$.

1979

	Terminal F[1]		F 1980		$F_{0.1}$ 1981		Catch 1981
(a)[2]	0.19	0.09	0.21	0.11	0.34	0.18	9085
(b)[2]	0.38	0.30	0.38	0.40	0.38	0.35	3975

[1] Average F 8-14 male and 9-19 female
[2] (a) commercial and research ratio (b) average from cohorts
Note: For details of projections see Table 12-18.

Catch per unit effort data from commercial trawlers indicate a fairly strong increase from 1978 to 1979 (Fig. 3) and a similar trend is indicated for the research vessel data (Fig. 4).

It would appear that the stock is probably in a relatively stable condition with catches since 1974 averaging around 5,000 t. Because of the difficulty in arriving at precise parameters it would seem best at this time at least, to keep the TAC in 1981 at the 5,000 t level.

Cohort runs are shown in Tables 8 and 9 for F_T determined by method (a) for partial recruitment and in Tables 10 and 11 for method (b).

The population at the beginning of 1979 was used for the catch projections.

Recruitment for the projections are the G.M. of the number of 6-yr-olds 1973-78.

Discussion and Conclusions

Obviously the choice of a method of calculating partial recruitment is critical in this assessment. The pattern of partial recruitment derived from commercial and research vessel catches (Table 3(a)) produces relatively high Fs at the lower age groups with a peak around age 10-11. On the other hand an examination of cohort runs back to 1973 suggests that fishing mortality

References

Pitt, T.K. 1979. American Plaice in ICNAF Subdivision 3Ps - Stock Assessment Update. CAFSAC Research Document 79/10.

Table 1. Catch for plaice in Subdivision 3Ps

YEAR	CANADA (TONS)	ALL COUNTRIES (TONS)	TAC (TONS)
1967	3,275	4,494	
1968	5,523	14,280	
1969	4,066	6,491	
1970	11,545	12,328	
1971	5,953	7,182	
1972	5,922	6,538	
1973	12,812	13,360	
1974	6,330	6,598	11.0
1975	3,813	4,211	11.0
1976	5,383	5,428	8.0
1977	4,605	4,605	6.0
1978	3,611	3,658	4.0
1979	3,563*	3,563*	4.0
1980			5.0

*Preliminary

Table 2. List of data used to calculate numbers caught at age from Subdivision 3Ps.

Month	Gear	No. Measured Male	No. Measured Female	Avg. Length Male+Female	Avg. Wt. Male+Female	Nominal Catch(T)	Numbers Caught
Jan.	OT	195	234	37.29	0.50	442	883
Feb.	OT	675	1392	46.45	1.07	373	349
Mar.	OT	277	1001	48.16	1.13	1371	1213
Oct.	OT	125	516	41.88	0.70	284	548
Nov.	OT	279	302	41.27	0.78	223	286

Table 3. Partial recruitment and average weights used in the assessment and a comparison with weights used in the 1979 assessment. (a) ratio of commercial to research catches (b) average Fs from cohort.

Age	Partial Recruitment				Average weight (kg)			
	Male		Female		Male		Female	
	(b)	(a)	(b)	(a)	1978	1979	1978	1979
6	.04	.15	.01	.09	.250	.346	.250	.344
7	.08	.25	.04	.09	.260	.394	.272	.306
8	.16	1.00	.08	.26	.395	.408	.375	.485
9	.34	1.90	.16	1.17	.479	.501	.480	.520
10	.49	5.00	.21	2.86	.600	.596	.575	.697
11	1.00	4.95	.26	2.70	.801	.758	.898	.997
12	1.57	3.70	.31	2.57	.868	1.115	1.101	1.275
13	2.00	1.30	.46	2.29	1.165	1.399	1.242	1.697
14	1.00	1.00	.58	2.00	1.214	1.500	1.798	2.044
15			.61	1.57			1.832	2.285
16			1.00	1.29			2.327	2.873
17			1.08	1.14			2.506	3.086
18			1.76	1.14			2.520	2.907
19			1.00	1.00			2.600	3.000

Table 4. Regression of biomass on CPUE. Numbers in parentheses are predicted using partial recruitment method (a).

YEAR	1973	1974	1975	1976	1977	1978	1979
CPUE	506	331	307	331	326	308	407
MALE	Average F in fully recruited ages (8-14) = 0.189						
BIOMASS	6.9	4.8	5.1	5.5	4.5	5.1	5.3
AGE 8-14						(4.8)	(5.8)
TONS $X10^{-3}$							
FEMALE	Average F in fully recruited age groups = 0.09						
	42.4	31.6	29.5	30.4	30.6	29.7	32.6
						(29.5)	(35.9)

(a) MALE. Regression of biomass on CPUE 1973-77 R^2=0.828

Biomass = CPUE X 0.010 + 1.619

(b) FEMALE. Regression of biomass on CPUE 1973-77 R^2 = 0.994

Biomass = CPUE X 0.065 + 9.447

Table 5. Biomass from cohort on commercial C.P.U.E. (Method (b)).

Year	CPUE	.30	.35	.40		.30	.40	.45
		FEMALE					MALE	
1973	506	35.4	35.0	34.8		6.8	6.8	6.8
1974	331	24.0	23.4	23.1		4.3	4.3	4.3
1975	307	21.2	20.3	19.7		4.5	4.5	4.4
1976	331	23.0	21.6	20.5		4.9	4.8	4.8
1977	326	25.3	23.0	21.3		4.7	4.4	4.2
1978	308	28.4	25.0	22.5		5.4	4.9	4.6
1979	409	33.7	29.1	25.7		6.0	5.3	4.8
1973-77	R^2	.960	.981	.977		0.948	0.957	.951
Predicted	'79	29.0	28.2	27.5		5.6	5.6	5.5
1973-78	R^2	.742	.891	.947		0.771	0.896	0.930
Predicted	'79	29.5	28.5	27.7		5.7	5.6	5.6
1973-79	R^2	.735	.900	.927		0.799	.881	0.836
$\bar{F}$ 9-19		.22	.26	.30	$\bar{F}$ 8-14	.28	.38	.42

Table 6. Details of regression of numbers from cohort runs on numbers in populations from surveys using partial recruitment method (a).

MALE

Year	No. from Surveys	No. from cohort runs Ave. F Ages 8-14 ( ) = F. at age 14 1979 0.14(.05)	0.19(.07)	0.24(.09)
1973	35.1	10.7	10.7	10.7
1974	11.7	9.1	8.8	8.5
1975	4.1	10.2	9.5	9.0
1976	10.0	11.1	10.0	9.2
1977	6.7	9.5	8.0	7.0
1978	16.2	11.8	9.3	7.3
1979	21.8	13.7	10.0	7.2
	Predicted 1979	(10.3)	(9.9)	(9.5)
1973-77	r^2=	0.123	0.449	0.582
	a =	9.804	8.614	7.772
	b =	0.023	0.056	0.082
1973-79	r^2=	0.167	0.658	0.191

FEMALE		Ave. F ages 9-19 ( ) = F at age 19 1979 .07(.04)	.09(.05)	0.14(.08)
1973	63.5	37.8	35.1	31.1
1974	45.3	33.9	30.5	25.4
1975	5.3	33.0	29.0	23.1
1976	26.8	33.1	28.7	22.1
1977	17.3	32.6	27.7	20.2
1978	36.9	31.2	25.8	17.8
1979	24.2	36.9	29.7	19.1
	Predicted 1979	(33.5)	(29.4)	(23.3)
1973-77	r^2=	0.752	0.763	0.739
	a =	31.541	26.701	19.425
	b =	0.080	0.111	0.157
1973-79	r^2=	0.413	0.237	0.410

Table 7. Numbers from cohort on numbers from research surveys (method (b)).

Year		F in oldest age group 1 .60	.65	.70		.40	.45	.50
Female					Male			
1973	63.5	25.4	25.3	25.2	35.1	10.5	10.5	10.5
1974	45.3	19.3	19.1	18.9	11.7	7.9	7.9	7.9
1975	5.3	17.2	16.9	16.6	4.1	8.3	8.2	8.2
1976	26.8	17.7	17.2	16.8	10.0	8.9	8.7	8.6
1977	17.3	17.9	17.2	16.5	6.7	8.4	8.0	7.6
1978	36.9	18.6	17.5	16.5	16.2	9.4	8.7	8.1
1979	24.2	19.6	18.3	17.0	21.8	10.5	9.5	8.5
1973-79	R^2	.787	.794	.799		0.811	0.880	0.862
Predicted '79		18.6	18.1	17.7		9.4	9.3	9.2
1973-78	R^2	.747	.716	.655		0.794	0.866	0.794
Predicted '79		18.3	17.8	17.3		9.4	9.3	9.1
1973-79	R^2	.632	.713	.693		0.740	0.845	0.736
$\bar{F}$ 9-19		0.45	.48	.52	$\bar{F}$ 8-14	.38	.42	.47

Table 8

3PS 1973-1979 MALE

NATURAL MORTALITY= 0.25

PARTIAL RECRUITMENT MULTIPLIER

0.1500	0.2500	1.0000	1.9000	5.0000	4.9500	3.7000	1.3000	1.0000

ASSUMED FISHING MORTALITY FOR LAST AGES

0.6000	0.3000	0.3000	0.3000	0.3000	0.3000	0.0700

ESTIMATED POPULATION

AGE YEAR	1973	1974	1975	1976	1977	1978	1979
6	7270.	6157.	4636.	6908.	7545.	6058.	4868.
7	5629.	5632.	4728.	3527.	5300.	5861.	4689.
8	2943.	4047.	4141.	3505.	2540.	4095.	4474.
9	2474.	1959.	2861.	3042.	2216.	1868.	2978.
10	1464.	1379.	1164.	2105.	1717.	1471.	1087.
11	2195.	718.	760.	729.	1189.	1056.	763.
12	1176.	523.	368.	447.	235.	607.	463.
13	464.	136.	218.	146.	140.	114.	233.
14	2.	30.	52.	82.	52.	61.	17.

KNOWN CATCHES

AGE YEAR	1973	1974	1975	1976	1977	1978	1979
6	34.	76.	95.	90.	17.	33.	45.
7	382.	278.	201.	234.	37.	103.	72.
8	377.	330.	207.	582.	125.	240.	268.
9	621.	410.	139.	739.	289.	417.	329.
10	478.	355.	201.	510.	319.	434.	286.
11	1344.	217.	164.	377.	362.	407.	199.
12	884.	215.	159.	236.	78.	271.	94.
13	375.	61.	99.	70.	55.	82.	18.
14	1.	7.	12.	19.	12.	14.	1.

ESTIMATE FISHING MORTALITY

AGE YEAR	1973	1974	1975	1976	1977	1978	1979
6	0.0053	0.0141	0.0235	0.0149	0.0026	0.0062	
7	0.0800	0.0576	0.0494	0.0782	0.0079	0.0201	
8	0.1568	0.0970	0.0583	0.2084	0.0574	0.0687	
9	0.3347	0.2707	0.0566	0.3219	0.1599	0.2917	
10	0.4621	0.3450	0.2177	0.3209	0.2364	0.4070	
11	1.1836	0.4192	0.2802	0.8815	0.4229	0.5741	
12	1.9082	0.6263	0.6732	0.9104	0.4712	0.7053	
13	2.4773	0.7106	0.7232	0.7829	0.5878	1.6743	
14	0.6000	0.3000	0.3000	0.3000	0.3000	0.3000	0.0700

TOTAL F AGES 8 TO 12

1973	1974	1975	1976	1977	1978	1979
0.5266	0.2239	0.1121	0.3309	0.1843	0.2489	

POPULATION WTS AND NOS

	1973	1974	1975	1976	1977	1978	1979
WT	11670.	9122.	8575.	9244.	9229.	9526.	8918.
NO	23618.	20582.	18928.	20492.	20935.	21191.	19571.

POPULATION WTS AND NOS AGE 8 TO 14

	1973	1974	1975	1976	1977	1978	1979
WT	6937.	4772.	5108.	5465.	4530.	5120.	5386.
NO	10718.	8793.	9564.	10058.	8090.	9272.	10014.

Table 9 3PS AM PLAICE FEMALE

NATURAL MORTALITY= 0.20

PARTIAL RECRUITMENT MULTIPLIER

0.0900	0.0900	0.2600	1.1700	2.8600	2.7000	2.5700	2.2900
2.0000	1.5700	1.2900	1.1400	1.1400	1.0000		

ASSUMED FISHING MORTALITY FOR LAST AGES

	0.5000	0.3000	0.3000	0.3000	0.3000	0.3000	0.0500

ESTIMATED POPULATION

AGE YEAR	1973	1974	1975	1976	1977	1978	1979
6	14183.	15173.	12310.	20795.	35440.	33035.	12777.
7	13732.	11601.	12209.	9926.	16997.	29009.	27029.
8	10738.	11075.	9042.	9618.	7939.	13814.	23657.
9	10755.	8388.	8590.	7035.	7397.	6278.	11077.
10	6325.	8309.	6185.	6643.	5072.	5507.	4618.
11	4876.	4760.	6019.	4864.	4770.	3612.	3966.
12	3039.	3396.	3390.	4712.	3452.	3279.	2629.
13	2474.	2072.	2179.	2485.	3433.	2549.	2270.
14	2201.	1214.	988.	1510.	1687.	2607.	1864.
15	1843.	772.	557.	603.	1056.	1167.	1941.
16	1172.	628.	433.	386.	348.	691.	847.
17	1046.	211.	358.	264.	201.	96.	497.
18	732.	471.	86.	207.	126.	40.	60.
19	665.	258.	254.	13.	131.	21.	23.

KNOWN CATCHES

AGE YEAR	1973	1974	1975	1976	1977	1978	1979
6	12.	236.	169.	31.	7.	20.	52.
7	186.	505.	418.	208.	113.	103.	110.
8	446.	527.	406.	528.	245.	258.	277.
9	549.	755.	431.	760.	607.	577.	571.
10	463.	866.	221.	739.	598.	599.	559.
11	659.	560.	239.	586.	693.	362.	455.
12	460.	665.	321.	469.	306.	458.	288.
13	897.	783.	302.	384.	225.	247.	223.
14	1139.	483.	227.	200.	237.	214.	161.
15	974.	220.	77.	161.	191.	120.	133.
16	827.	173.	100.	127.	209.	76.	48.
17	426.	96.	95.	99.	138.	21.	25.
18	377.	145.	64.	42.	91.	11.	3.
19	239.	61.	60.	3.	31.	5.	1.

ESTIMATE FISHING MORTALITY

AGE YEAR	1973	1974	1975	1976	1977	1978	1979
6	0.0009	0.0173	0.0153	0.0016	0.0002	0.0007	0.0
7	0.0151	0.0493	0.0386	0.0234	0.0074	0.0039	0.0
8	0.0470	0.0540	0.0509	0.0626	0.0347	0.0209	0.0
9	0.0581	0.1048	0.0570	0.1271	0.0951	0.1071	0.0
10	0.0844	0.1224	0.0403	0.1312	0.1396	0.1281	0.0
11	0.1618	0.1393	0.0449	0.1429	0.1750	0.1174	0.0
12	0.1831	0.2439	0.1105	0.1165	0.1031	0.1677	0.0
13	0.5121	0.5407	0.1663	0.1872	0.0752	0.1133	0.0
14	0.8482	0.5796	0.2930	0.1582	0.1687	0.0951	0.0
15	0.8769	0.3784	0.1660	0.3494	0.2231	0.1206	0.0
16	1.5127	0.3631	0.2949	0.4520	1.0878	0.1295	0.0
17	0.5983	0.6967	0.3476	0.5356	1.4207	0.2764	0.0
18	0.8417	0.4162	1.7151	0.2542	1.5867	0.3649	0.0
19	0.5000	0.3000	0.3000	0.3000	0.3000	0.3000	0.0500

TOTAL F AGES 9 TO 17						
0.2351	0.1874	0.0807	0.1470	0.1383	0.1217	

POPULATION WTS AND NOS

	1973	1974	1975	1976	1977	1978	1979
WT	56654.	45729.	41805.	45247.	51852.	56609.	56732.
NO	73783.	68328.	62599.	69061.	88050.	101705.	93255.

POPULATION WTS AND NOS AGE 9 TO 19

	1973	1974	1975	1976	1977	1978	1979
WT	42365.	31589.	29450.	30391.	30609.	29668.	32591.
NO	35129.	30479.	29038.	28722.	27674.	25847.	29791.

Table 10

3PS 1973-1979 MALE

NATURAL MORTALITY= 0.25

PARTIAL RECRUITMENT MULTIPLIER

0.0400	0.0800	0.1600	0.3400	0.4900	1.0000	1.5700	2.0000
1.0000							

ASSUMED FISHING MORTALITY FOR LAST AGES

1.2000	0.5700	0.4500	0.8000	0.4000	0.3000	0.4000

ESTIMATED POPULATION

AGE	YEAR	1973	1974	1975	1976	1977	1978	1979
6		6203.	5857.	6599.	6777.	8214.	3353.	3203.
7		4746.	4801.	4495.	5055.	5199.	6382.	2582.
8		2883.	3359.	3493.	3323.	3730.	4016.	4879.
9		2474.	1913.	2325.	2538.	2074.	2795.	2916.
10		1433.	1379.	1128.	1688.	1324.	1361.	1809.
11		2102.	694.	760.	701.	864.	750.	677.
12		1152.	451.	349.	447.	213.	354.	225.
13		448.	117.	161.	132.	140.	97.	36.
14		2.	18.	37.	38.	41.	61.	3.

KNOWN CATCHES

AGE	YEAR	1973	1974	1975	1976	1977	1978	1979
6		34.	76.	95.	90.	17.	33.	45.
7		382.	278.	201.	234.	37.	103.	72.
8		377.	330.	207.	582.	125.	240.	268.
9		621.	410.	139.	739.	289.	417.	329.
10		478.	355.	201.	510.	319.	434.	286.
11		1344.	217.	164.	377.	362.	407.	199.
12		884.	215.	159.	236.	78.	271.	94.
13		375.	61.	99.	70.	55.	82.	18.
14		1.	7.	12.	19.	12.	14.	1.

ESTIMATE FISHING MORTALITY

AGE	YEAR	1973	1974	1975	1976	1977	1978	1979
6		0.0062	0.0148	0.0164	0.0152	0.0023	0.0112	0.0
7		0.0956	0.0679	0.0520	0.0539	0.0081	0.0185	0.0
8		0.1603	0.1180	0.0695	0.2212	0.0387	0.0701	0.0
9		0.3347	0.2782	0.0702	0.4004	0.1718	0.1852	0.0
10		0.4747	0.3450	0.2255	0.4191	0.3187	0.4486	0.0
11		1.2893	0.4371	0.2802	0.9399	0.6435	0.9544	0.0
12		2.0390	0.7772	0.7253	0.9104	0.5351	2.0256	0.0
13		2.9647	0.8968	1.1871	0.9219	0.5878	3.1039	0.0
14		1.2000	0.5700	0.4500	0.8000	0.4000	0.3000	0.4000

TOTAL F AGES 8 TO 12

1973	1974	1975	1976	1977	1978
0.5411	0.2510	0.1305	0.3833	0.1767	0.2435

POPULATION WTS AND NOS

	1973	1974	1975	1976	1977	1978	1979
WT	10790.	8261.	8508.	9185.	9330.	8623.	7470.
NO	21442.	18589.	19348.	20700.	21800.	19168.	16330.

POPULATION WTS AND NOS AGE 8 TO 14

	1973	1974	1975	1976	1977	1978	1979
WT	6774.	4343.	4454.	4848.	4440.	4949.	5344.
NO	10494.	7931.	8254.	8868.	8388.	9433.	10545.

Table 11

3PS AM PLAICE FEMALE

NATURAL MORTALITY= 0.20

PARTIAL RECRUITMENT MULTIPLIER

0.0100	0.0400	0.0800	0.1600	0.2100	0.2600	0.3100	0.4600
0.5800	0.6100	1.0000	1.0800	1.7600	1.0000		

ASSUMED FISHING MORTALITY FOR LAST AGES

1.0000	0.6000	0.8000	0.5000	0.5000	0.3000	0.4500

ESTIMATED POPULATION

AGE YEAR	1973	1974	1975	1976	1977	1978	1979
6	13537.	16726.	17232.	17117.	13033.	8329.	12777.
7	10550.	11072.	13481.	13955.	13986.	10664.	6801.
8	7107.	8469.	8608.	10659.	11237.	11349.	8638.
9	6331.	5415.	6457.	6680.	8249.	8979.	9058.
10	3995.	4687.	3751.	4897.	4782.	6204.	6829.
11	3461.	2852.	3063.	2871.	3340.	3374.	4538.
12	2861.	2237.	1828.	2284.	1820.	2108.	2435.
13	2409.	1926.	1230.	1206.	1445.	1213.	1311.
14	2201.	1160.	868.	734.	640.	980.	770.
15	1743.	772.	513.	506.	420.	310.	609.
16	1164.	546.	433.	350.	268.	171.	145.
17	844.	205.	290.	264.	172.	31.	71.
18	597.	305.	81.	152.	126.	16.	6.
19	410.	148.	119.	8.	86.	21.	3.

KNOWN CATCHES

AGE YEAR	1973	1974	1975	1976	1977	1978	1979
6	12.	236.	169.	31.	7.	20.	52.
7	186.	505.	418.	208.	113.	103.	110.
8	446.	527.	406.	528.	245.	258.	277.
9	549.	755.	431.	760.	607.	577.	571.
10	463.	866.	221.	739.	598.	599.	559.
11	659.	560.	239.	586.	693.	362.	455.
12	460.	665.	321.	469.	306.	458.	288.
13	897.	783.	302.	384.	225.	247.	223.
14	1139.	483.	227.	200.	237.	214.	161.
15	974.	220.	77.	161.	191.	120.	133.
16	827.	173.	100.	127.	209.	76.	48.
17	426.	96.	95.	99.	138.	21.	25.
18	377.	145.	64.	42.	91.	11.	3.
19	239.	61.	60.	3.	31.	5.	1.

ESTIMATE FISHING MORTALITY

AGE YEAR	1973	1974	1975	1976	1977	1978	1979
6	0.0010	0.0157	0.0109	0.0020	0.0006	0.0027	0.0
7	0.0197	0.0517	0.0349	0.0166	0.0090	0.0107	0.0
8	0.0719	0.0712	0.0535	0.0563	0.0244	0.0254	0.0
9	0.1007	0.1673	0.0766	0.1344	0.0848	0.0737	0.0
10	0.1371	0.2284	0.0673	0.1825	0.1487	0.1128	0.0
11	0.2363	0.2446	0.0905	0.2557	0.2604	0.1262	0.0
12	0.1957	0.3983	0.2157	0.2574	0.2055	0.2746	0.0
13	0.5303	0.5966	0.3166	0.4335	0.1888	0.2549	0.0
14	0.8482	0.6163	0.3409	0.3585	0.5260	0.2763	0.0
15	0.9612	0.3764	0.1814	0.4338	0.6990	0.5588	0.0
16	1.5372	0.4313	0.2949	0.5120	1.9740	0.6767	0.0
17	0.8167	0.7292	0.4489	0.5356	2.1837	1.4307	0.0
18	1.1968	0.7447	2.0720	0.3652	1.5867	1.4571	0.0
19	1.0000	0.6000	0.8000	0.5000	0.5000	0.3000	0.4500

TOTAL F AGES 9 TO 17

0.3321	0.2968	0.1287	0.2192	0.1834	0.1352	

POPULATION WTS AND NOS

	1973	1974	1975	1976	1977	1978	1979
WT	45991.	35962.	33340.	34978.	34135.	32142.	33617.
NO	57210.	56520.	57944.	61683.	59606.	53749.	53991.

POPULATION WTS AND NOS AGE 9 TO 19

	1973	1974	1975	1976	1977	1978	1979
WT	34659.	22712.	19112.	19650.	19921.	20509.	22951.
NO	26016.	20253.	18623.	19952.	21350.	23406.	25775.

Table 12.

Catch projection for 1979-80 using partial recruitment multipliers from method (a), Subdivision 3Ps plaice, male.

NATURAL MORTALITY# 0.2500 YEAR 1979

AGE	POP. NO. %X10-3<	CATCH NO. %X10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.
6	4868.	45.	0.011	0.346	1684.3	15.6	3749.7
7	4689.	72.	0.018	0.394	1847.5	28.4	3586.7
8	4474.	268.	0.070	0.408	1825.4	109.3	3248.8
9	2978.	329.	0.133	0.501	1492.0	164.8	2030.4
10	1087.	286.	0.350	0.596	647.9	170.5	596.6
11	763.	199.	0.347	0.758	578.4	150.8	420.0
12	463.	94.	0.260	1.115	516.2	104.8	278.0
13	233.	18.	0.092	1.399	326.0	25.2	165.5
14	17.	1.	0.069	1.500	25.5	1.5	12.4
TOTAL	19572.	1312.	$\bar{F}$ = 0.189		8943.1	770.9	14088.1

8-14

NATURAL MORTALITY# 0.2500 YEAR 1980

AGE	POP. NO. %X10-3<	CATCH NO. %X10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.
6	6000.	63.	0.012	0.346	2076.0	21.9	4617.1
7	3750.	66.	0.020	0.394	1477.4	25.9	2862.5
8	3587.	244.	0.080	0.408	1463.4	99.7	2578.5
9	3249.	407.	0.152	0.501	1627.6	203.7	2173.4
10	2030.	598.	0.401	0.596	1210.1	356.7	1058.9
11	597.	168.	0.379	0.758	452.2	127.2	318.0
12	420.	96.	0.297	1.115	468.3	107.1	243.0
13	278.	24.	0.104	1.399	389.0	34.1	195.1
14	166.	11.	0.080	1.500	248.3	16.9	119.0
TOTAL	20076.	1678.			9412.2	993.2	14165.6

8-14 $\bar{F}$ = .213

Table 13. Catch projections for 1981-82 using partial recruitment multipliers from method (a), Subdivision 3Ps plaice, male.

NATURAL MORTALITY# 0.2500 YEAR 1981

AGE	POP. NO. %X10-3<	CATCH NO. %X10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.
6	6000.	100.	0.019	0.346	2076.0	34.6	4584.9
7	4617.	129.	0.032	0.394	1819.1	50.7	3482.5
8	2862.	305.	0.128	0.408	1167.9	124.5	1961.4
9	2579.	495.	0.243	0.501	1291.8	247.8	1574.9
10	2173.	921.	0.640	0.596	1295.3	549.0	892.5
11	1059.	446.	0.634	0.758	802.7	337.8	437.5
12	318.	107.	0.474	1.115	354.6	119.6	154.2
13	243.	33.	0.166	1.399	340.0	46.2	160.3
14	195.	21.	0.128	1.500	292.7	31.2	133.7
TOTAL	20047.	2556.	$\bar{F}$ = 0.344 8-14		9440.2	1541.4	13362.0

NATURAL MORTALITY# 0.2500 YEAR 1982

AGE	POP. NO. %X10-3<	CATCH NO. %X10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.
6	6000.	100.	0.019	0.346	2076.0	34.6	4584.9
7	4585.	128.	0.032	0.394	1806.4	50.4	3458.2
8	3483.	371.	0.128	0.408	1420.9	151.4	2386.3
9	1961.	376.	0.243	0.501	982.7	188.5	1198.0
10	1575.	667.	0.640	0.596	938.7	397.8	646.8
11	893.	376.	0.634	0.758	676.5	284.7	368.7
12	437.	148.	0.474	1.115	487.8	164.5	212.1
13	154.	21.	0.166	1.399	215.7	29.3	101.7
14	160.	17.	0.128	1.500	240.5	25.6	109.9
TOTAL	19248.	2204.			8845.2	1326.9	13066.6

Table 14. Catch projection for 1979-80 using partial recruitment multipliers from method (a), Subdivision 3Ps plaice, female.

NATURAL MORTALITY# 0.2000 YEAR 1979

AGE	POP. NO. XX10=3<	CATCH NO. XX10=3<	FISHING MORT.	MEAN WT. KG.	POP. WT. XMETRIC TONS<	CATCH WT. XMETRIC TONS<	RESIDUAL POP. NOS.
6	12777.	52.	0.005	0.344	4395.3	17.9	10408.7
7	27029.	110.	0.005	0.306	8270.9	33.7	22019.1
8	23657.	277.	0.014	0.485	11473.6	134.3	19099.4
9	11077.	571.	0.059	0.520	5760.0	296.9	8549.5
10	4618.	559.	0.143	0.697	3218.7	389.6	3277.1
11	3966.	455.	0.136	0.997	3954.1	453.6	2834.2
12	2629.	288.	0.129	1.275	3352.0	367.2	1891.9
13	2270.	223.	0.115	1.697	3852.2	378.4	1656.6
14	1864.	161.	0.100	2.044	3810.0	329.1	1380.9
15	1941.	133.	0.079	2.285	4435.2	303.9	1468.4
16	847.	48.	0.065	2.873	2433.4	137.9	649.8
17	497.	25.	0.058	3.086	1533.7	77.2	384.0
18	60.	3.	0.057	2.907	174.4	8.7	46.4
19	23.	1.	0.050	3.000	69.0	3.0	17.9
TOTAL	93255.	2906.	$\bar{F}_{9-19} = 0.090$		56732.6	2931.5	73683.9

NATURAL MORTALITY# 0.2000 YEAR 1980

AGE	POP. NO. XX10=3<	CATCH NO. XX10=3<	FISHING MORT.	MEAN WT. KG.	POP. WT. XMETRIC TONS<	CATCH WT. XMETRIC TONS<	RESIDUAL POP. NOS.
6	19000.	86.	0.005	0.344	6536.0	29.5	15478.3
7	10409.	47.	0.005	0.306	3185.1	14.4	8479.5
8	22019.	297.	0.015	0.485	10679.3	144.1	17759.3
9	19099.	1172.	0.070	0.520	9931.7	609.3	14580.1
10	8549.	1215.	0.170	0.697	5959.0	846.7	5905.4
11	3277.	443.	0.161	0.997	3267.3	441.5	2284.1
12	2834.	365.	0.153	1.275	3613.6	465.8	1991.2
13	1892.	219.	0.136	1.697	3210.6	370.9	1352.0
14	1657.	169.	0.119	2.044	3386.1	345.0	1204.2
15	1381.	112.	0.094	2.285	3155.3	257.0	1029.1
16	1468.	99.	0.077	2.873	4218.8	283.7	1113.2
17	650.	39.	0.068	3.086	2005.4	119.6	497.1
18	384.	23.	0.068	2.907	1116.2	66.6	293.7
19	46.	2.	0.060	3.000	139.2	7.4	35.8
TOTAL	92666.	4288.	$\bar{F}_{9-19} = 0.107$		60403.6	4001.6	72002.7

Table 15. Catch projections for 1981-82 using partial recruitment multipliers from method (α), Subdivisions 3Ps plaice, female.

NATURAL MORTALITY# 0.2000 YEAR 1981

AGE	POP. NO. %X10=3<	CATCH NO. %X10=3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.
6	19000.	154.	0.009	0.344	6536.0	53.1	15416.5
7	15478.	126.	0.009	0.306	4736.4	38.5	12559.0
8	8479.	197.	0.026	0.485	4112.5	95.7	6764.2
9	17759.	1766.	0.116	0.520	9234.8	918.5	12947.6
10	14580.	3272.	0.283	0.697	10162.3	2280.9	8994.9
11	5905.	1260.	0.267	0.997	5887.7	1256.0	3702.0
12	2284.	466.	0.254	1.275	2912.2	594.6	1450.6
13	1991.	368.	0.227	1.697	3379.1	624.3	1299.2
14	1352.	221.	0.198	2.044	2763.5	451.4	908.1
15	1204.	157.	0.155	2.285	2751.5	359.0	844.3
16	1029.	112.	0.128	2.873	2956.7	322.7	741.4
17	1113.	108.	0.113	3.086	3435.2	333.3	814.0
18	497.	48.	0.113	2.907	1444.9	140.2	363.5
19	294.	25.	0.099	3.000	881.1	75.4	217.8
TOTAL	90967.	8282.	$\bar{F}_{9-14} = 0.1$		61194.1	7543.5	67022.9

NATURAL MORTALITY# 0.2000 YEAR 1982

AGE	POP. NO. %X10=3<	CATCH NO. %X10=3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.
6	19000.	154.	0.009	0.344	6536.0	53.1	15416.5
7	15417.	125.	0.009	0.306	4717.4	38.3	12508.9
8	12559.	292.	0.026	0.485	6091.1	141.7	10018.6
9	6764.	673.	0.116	0.520	3517.4	349.8	4931.5
10	12948.	2906.	0.283	0.697	9024.5	2025.5	7987.8
11	8995.	1919.	0.267	0.997	8967.9	1913.1	5638.7
12	3702.	756.	0.254	1.275	4720.0	963.6	2351.1
13	1451.	268.	0.227	1.697	2461.6	454.8	946.4
14	1299.	212.	0.198	2.044	2655.6	433.8	872.6
15	908.	118.	0.155	2.285	2075.0	270.7	636.7
16	844.	92.	0.128	2.873	2425.7	264.7	608.2
17	741.	72.	0.113	3.086	2287.8	222.0	542.1
18	814.	79.	0.113	2.907	2366.3	229.6	595.2
19	363.	31.	0.099	3.000	1090.4	93.3	269.5
TOTAL	85805.	7698.			58936.9	7454.1	63323.9

Table 16. Catch projection for 1980-81 using partial recruitment multipliers from method (b) subdivision 3Ps plaice, male.

CATCH PROJECTION FOR 1980 USING POPULATION ESTIMATES FROM COHORT WITH TERMINAL F OF .400

AGE	POPULATION NUMBERS (000S)	POPULATION WEIGHT (MT)	FISHING MORTALITY	CATCH NUMBERS (000S)	CATCH WEIGHT (MT)	RESIDUAL NUMBERS (000S)	RESIDUAL WEIGHT (MT)
6	5500.	1903.	.016	79.	27.	4214.	1458.
7	2455.	967.	.033	70.	28.	1850.	729.
8	1948.	795.	.066	110.	45.	1421.	580.
9	3564.	1786.	.139	412.	206.	2414.	1210.
10	1982.	1181.	.201	321.	191.	1263.	752.
11	1158.	878.	.410	348.	264.	598.	454.
12	353.	394.	.644	150.	168.	144.	161.
13	93.	130.	.820	47.	66.	32.	45.
14	14.	21.	.410	4.	6.	7.	11.
TOTAL	17067.	8054.		1540.	1000.	11944.	5399.

CATCH PROJECTION FOR 1981 USING POPULATION ESTIMATES FROM COHORT WITH TERMINAL F OF .400

AGE	POPULATION NUMBERS (000S)	POPULATION WEIGHT (MT)	FISHING MORTALITY	CATCH NUMBERS (000S)	CATCH WEIGHT (MT)	RESIDUAL NUMBERS (000S)	RESIDUAL WEIGHT (MT)
6	5500.	1903.	.016	77.	27.	4215.	1459.
7	4214.	1660.	.032	117.	46.	3178.	1252.
8	1850.	755.	.064	102.	41.	1352.	551.
9	1421.	712.	.136	160.	80.	966.	484.
10	2414.	1439.	.196	382.	228.	1546.	921.
11	1263.	957.	.400	371.	281.	659.	500.
12	598.	667.	.628	250.	279.	249.	277.
13	144.	202.	.800	72.	100.	51.	71.
14	39.	59.	.400	12.	17.	20.	31.
TOTAL	17444.	8354.		1543.	1100.	12236.	5546.

Table 17. Catch projections for 1980 using partial recruitment multipliers from method (b), subdivision 3Ps plaice, female.

CATCH PROJECTION FOR 1980 USING POPULATION ESTIMATES FROM COHORT WITH TERMINAL F OF .450

AGE	POPULATION NUMBERS (000S)	POPULATION WEIGHT (MT)	FISHING MORTALITY	CATCH NUMBERS (000S)	CATCH WEIGHT (MT)	RESIDUAL NUMBERS (000S)	RESIDUAL WEIGHT (MT)
6	14000.	4816.	.005	68.	24.	11400.	3922.
7	10414.	3187.	.022	202.	62.	8344.	2553.
8	5469.	2652.	.043	210.	102.	4288.	2080.
9	6822.	3547.	.086	513.	267.	5123.	2664.
10	6901.	4810.	.113	672.	468.	5044.	3516.
11	5087.	5072.	.140	605.	604.	3619.	3608.
12	3305.	4214.	.167	463.	590.	2289.	2918.
13	1734.	2943.	.248	347.	589.	1107.	1879.
14	873.	1784.	.313	214.	437.	523.	1068.
15	486.	1111.	.329	124.	284.	286.	654.
16	379.	1089.	.540	145.	415.	181.	519.
17	76.	235.	.583	31.	95.	35.	107.
18	36.	105.	.950	20.	59.	11.	33.
19	4.	12.	.540	2.	5.	2.	6.
TOTAL	55586.	35576.		3615.	4000.	42253.	25528.

Table 18. Catch projection for 1981 using partial recruitment multipliers from method (b), subdivision 3Ps, female.

CATCH PROJECTION FOR 1981 USING POPULATION ESTIMATES FROM COHORT WITH TERMINAL F OF .450

AGE	POPULATION NUMBERS (000S)	POPULATION WEIGHT (MT)	FISHING MORTALITY	CATCH NUMBERS (000S)	CATCH WEIGHT (MT)	RESIDUAL NUMBERS (000S)	RESIDUAL WEIGHT (MT)
6	14000.	4816.	.004	44.	15.	11422.	3929.
7	11400.	3489.	.014	144.	44.	9204.	2816.
8	8344.	4047.	.028	209.	101.	6643.	3222.
9	4288.	2230.	.056	212.	110.	3320.	1726.
10	5123.	3571.	.074	329.	230.	3897.	2716.
11	5044.	5029.	.091	398.	397.	3771.	3759.
12	3619.	4615.	.109	338.	431.	2659.	3390.
13	2289.	3884.	.161	309.	525.	1595.	2707.
14	1107.	2264.	.203	185.	378.	740.	1513.
15	523.	1194.	.214	91.	209.	346.	790.
16	286.	822.	.350	77.	221.	165.	474.
17	181.	558.	.378	52.	160.	101.	313.
18	35.	101.	.616	15.	43.	15.	45.
19	13.	40.	.350	4.	11.	8.	23.
TOTAL	56253.	36659.		2407.	2875.	43886.	27424.

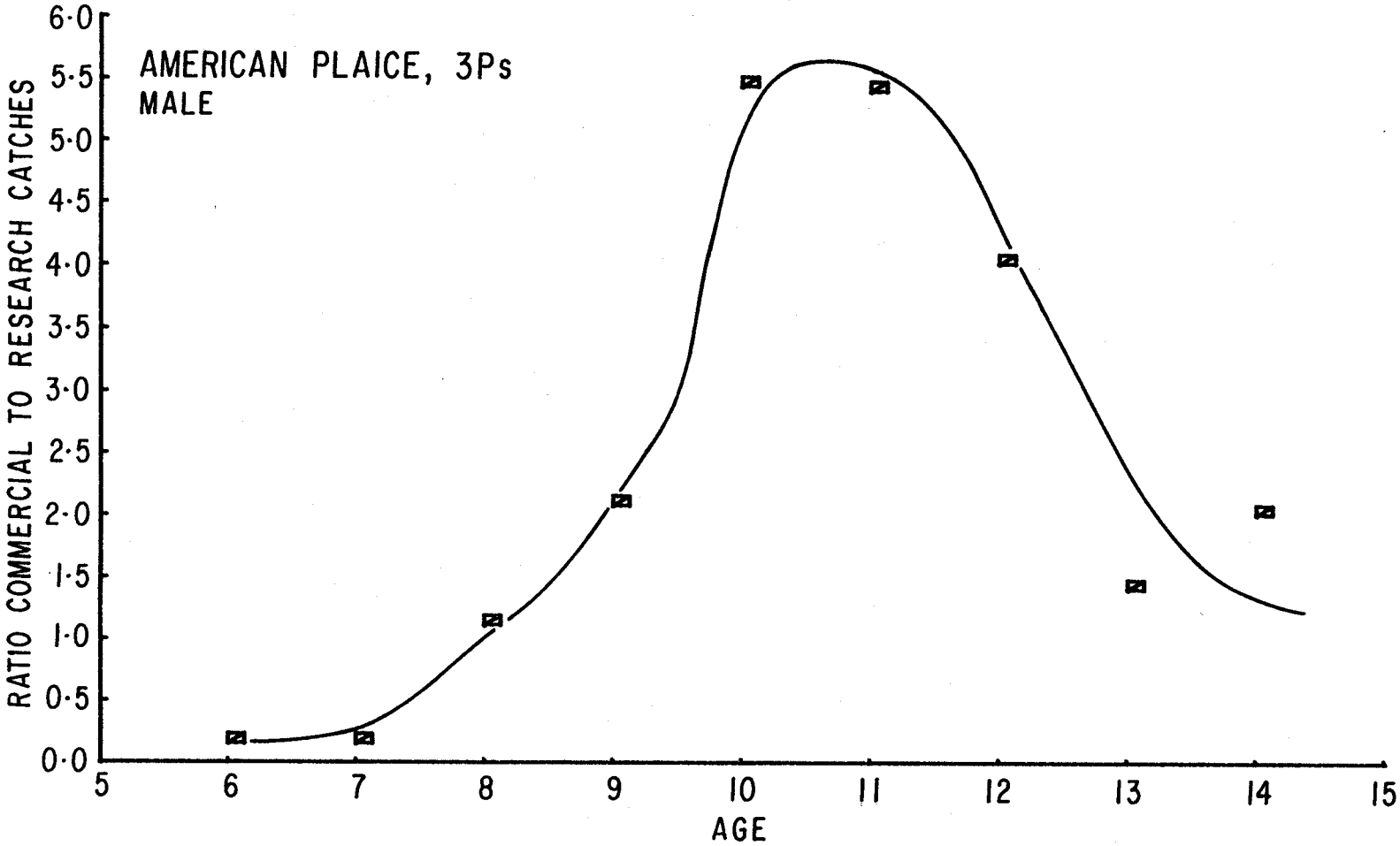

Fig. 1. Partial recruitment multipliers calculated from ratio of commercial to research age distributions-male.

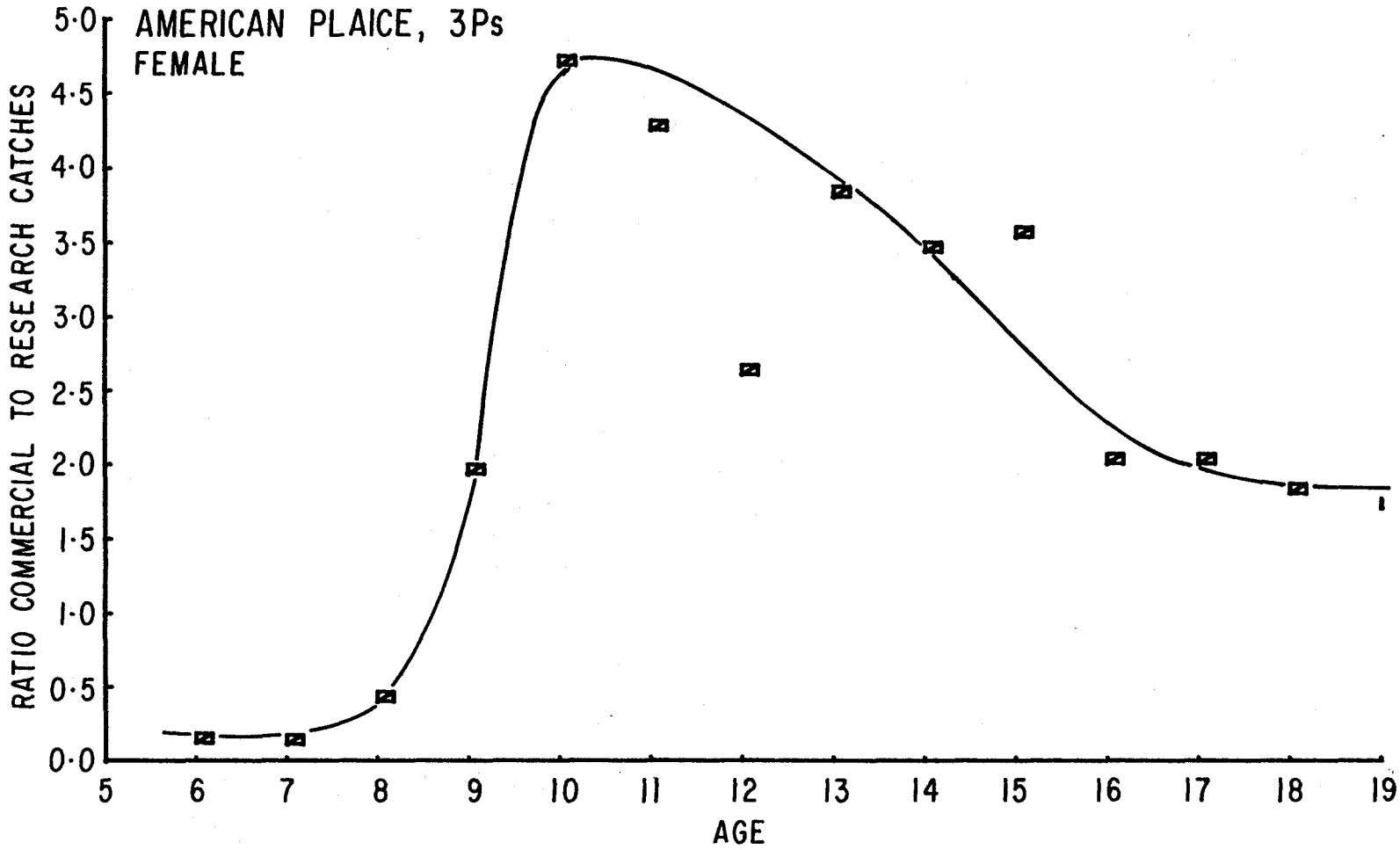

Fig. 2 Partial recruitment multipliers calculated from ratio of commercial to research age distributions, female.

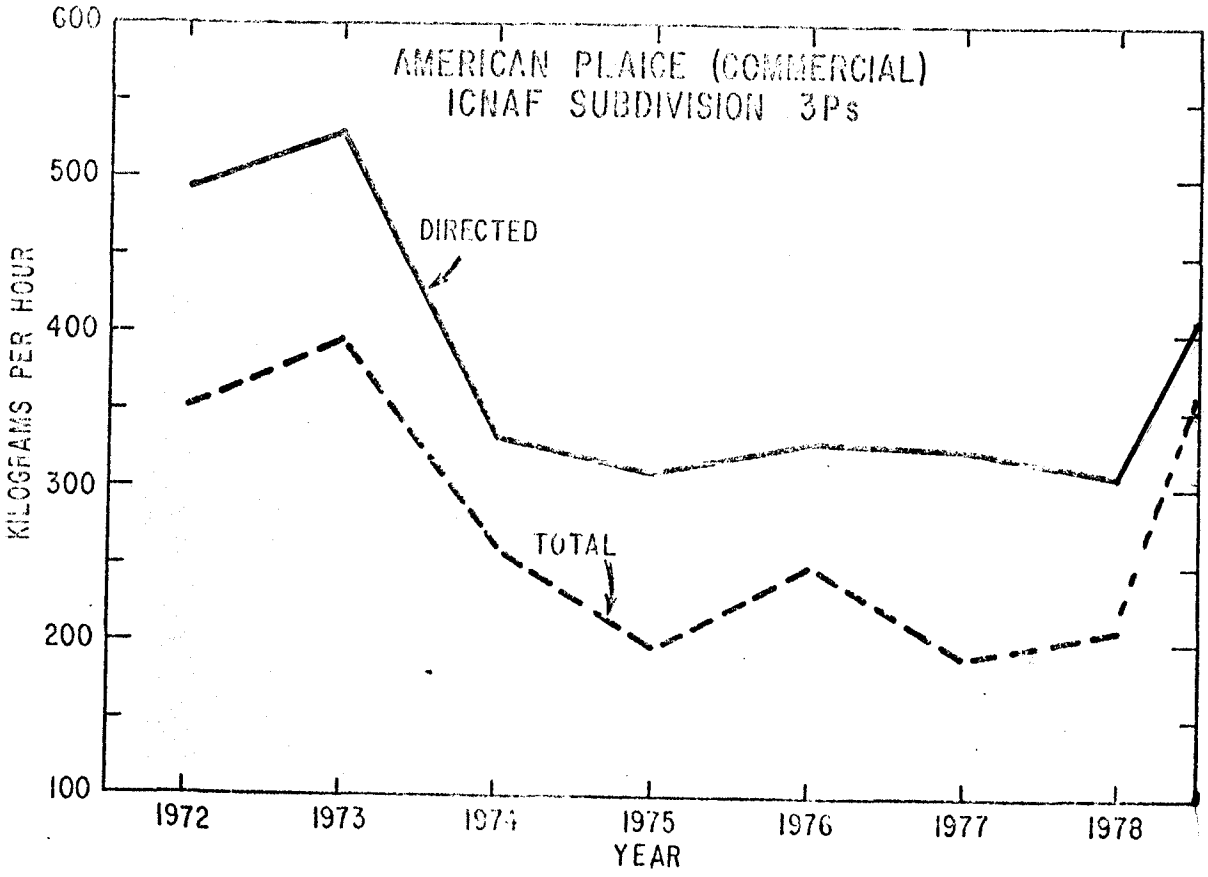

Fig. 3 Catch per unit effort for Canadian commercial otter trawlers, TC 5.

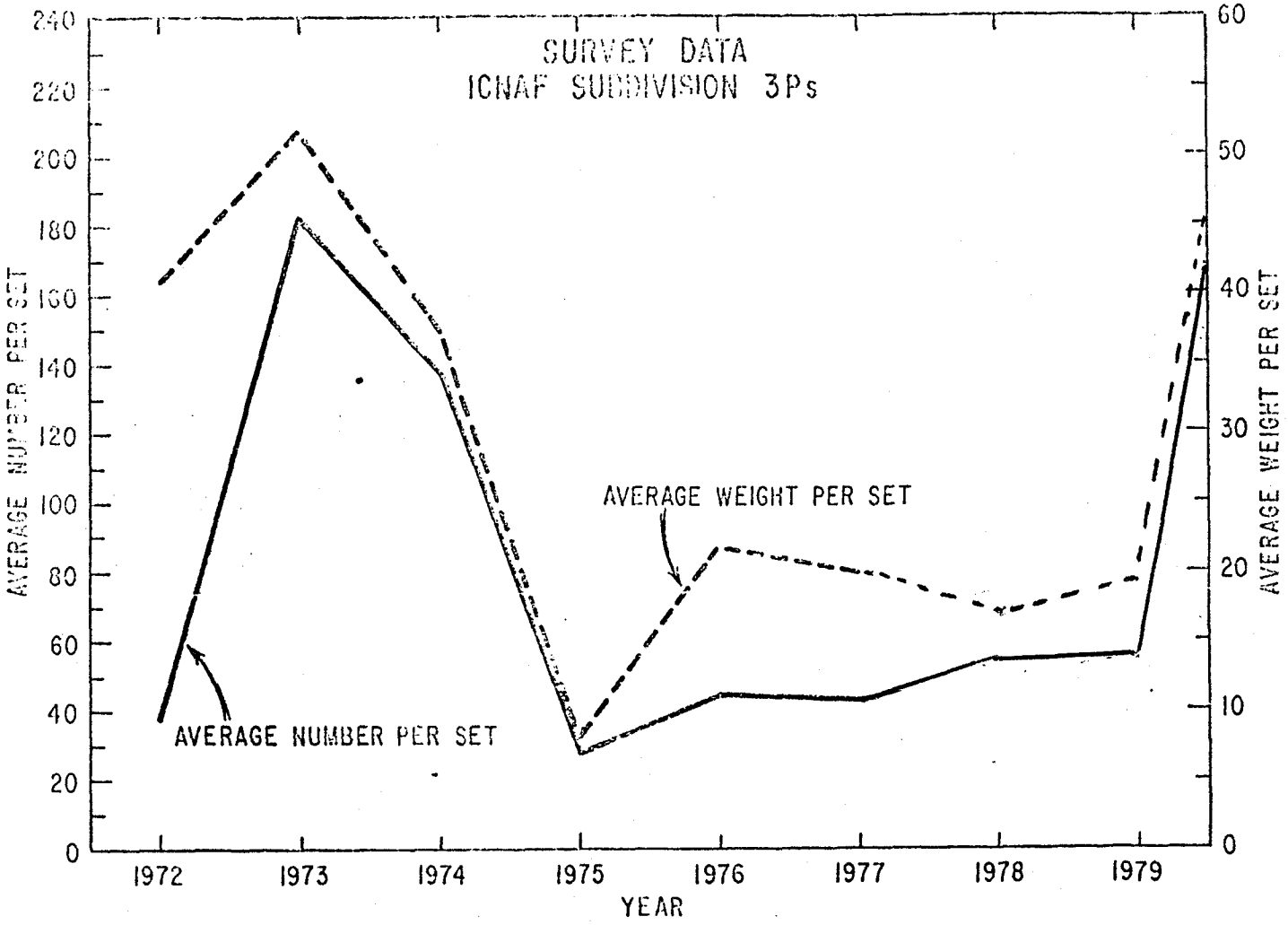

Fig. 4 Average number and weight per set of American Plaice from survey data for Subdivision 3Ps.