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An evaluation of recent management strategy for witch in the Gulf of St. Lawrence (NAFO Divisions 4RS)

by

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Abstract

The fishery for witch flounder in the Gulf of St. Lawrence has traditionally been a directed otter trawl fishery in the Esquiman Channel in winter on a prespawning concentration as well as a Danish seine fishery on the south side of St. George's Bay in summertime. Landings have averaged 2,000-3,500 t over the last 10 years. Effort appears to have been constant over the past several years with no apparent trend in CPUE. A large reduction in the numbers of older fish (> 16 years) has been experienced since 1976 and a substantial increase in the average size at age for the remaining age groups. Biomass surveys for groundfish in the Gulf of St. Lawrence have indicated that estimates of trawable biomass have been fairly stable over the past few years despite the reduction in numbers of old fish. This would indicate compensation by increased growth and recruitment.

Résumé

La pêche de la plie grise dans le golfe Saint-Laurent a été traditionnellement une pêche au chalut axée sur une concentration de poissons en condition préreproductrice dans le chenal Esquiman en hiver. En été, par contre, la pêche se pratique à la senne danoise dans le sud de la baie St. Georges. Les débarquements annuels moyens au cours des 10 dernières années ont été de 2 000 à 3 500 t. Depuis plusieurs années, l'effort de pêche semble se maintenir au même niveau et les prises par unité d'effort ne manifestent pas de tendance détectable. Depuis 1976 cependant, une forte diminution du nombre de poissons âgés (> 16 ans) à été rapportée alors que la taille moyenne à un âge donné chez les autres groupes d'âge a augmentée. Les relevés de la biomasse des poissons de fond dans le golfe Saint-Laurent indiquent que les estimations de la biomasse chalutable ont été passablement uniformes au cours des dernières années malgré la diminution du nombre de poissons âgés. Il y aurait, semble-t-il, compensation par croissance et recrutement accrus.

The fishery

The fishery in the Gulf of St. Lawrence has been traditionally by Newfoundland otter trawlers and Danish seiners. The otter trawlers generally fish in the wintertime in the Esquiman Channel just south west or west of St. Georges' Bay where these fish form a prespawning concentration. The Danish seiners, on the other hand, usually fish in the summertime on the south side of St. Georges' Bay where the bottom consists of muddy sand, a substrate highly conducive to witch flounder. Whether this area has a concentration of witch all year round or whether it is only occupied after spawning has not been determined.

Except for 1972 and 1973 the landings for the past 10 years from this stock has generally been in the order of 2000-3500 t with a couple of years of higher landings (Table 1). The landings from this stock have generally fluctuated around the status of the cod stock in the area in that when the cod quota was taken early, more pressure was placed upon witch as an alternate and vice-versa.

Management strategy

The first quota placed upon this stock was in 1977 at a level of 3500 t, which was considered to be a precautionary TAC based upon average catches of recent years. With the lack of an analytical assessment this TAC was carried forward and remained in effect for the year 1978. An analytical assessment presented in 1978 (Bowering, 1978) indicated the presence of many large old slow growing fish, many of which were being landed in jellied condition. While the assessment indicated that 3500 t was probably the maximum sustainable catch of this stock in its present condition the Subcommittee felt that it would be beneficial if the numbers of very old fish could

be reduced in order to enhance the quality of fish as well as bring about an increase in the growth rate of the recruiting fish. It was therefore decided to increase the TAC for 1979 to 5000 t with the understanding that this was not a sustainable level and later would probably be reduced when the objectives were reached.

An assessment in 1979, (Bowering, 1979) indicated that the management strategy was in fact working since the older fish were now less abundant in the surveys and in the commercial catch. It was again decided, however, that another year should be given to the 5000 t TAC since it was not reached in 1979. This was mainly due to a diversion of fishing effort from witch to Greenland halibut in the same general area. Consequently, the TAC for 1980 was again set at a level of 5000 t.

This document will attempt to assess the status of this stock in relation to management strategy over the past few years.

Age composition of the commercial otter trawl landings

Over the past 4 years from 1976 to 1979 the commercial landings of witch from Newfoundland otter trawlers have been sampled at processing plants on the south coast of Newfoundland usually in the month of January. The following commercial samples were available:

YEAR	NO. MEAS.	NO. AGED
1976	1887	536
1977	2875	719
1978	3424	457
1979	3812	852

Unfortunately, samples from the Danish seiners have never been taken.

Since there was no appreciable difference in the catch composition of males and females, the sexes were combined.

As indicated by Bowering (1979) the numbers caught at age have shown a marked reduction in the numbers of old fish. The age composition of 1976 catches ranged

from 8-26 years, 1977 from 7-21 years and 6-20 years in 1978. The catch figures for 1979 now show that there were no fish caught beyond age 16 indicating a remarkable reduction in the numbers of old fish since 1976 (Table 2). The value 1 was fabricated to accommodate a computer program for a later analysis for some age groups in the 1976, 1978 and 1979 landings (see Table 2).

It is also quite evident that the numbers of younger fish in the recent landings have increased in considerable proportions indicating a shift in the partial recruitment pattern with higher mortality on the younger age groups. It is also likely , however, that many of the younger age groups were caught in earlier years, discarded and never reported.

Catch per unit effort and mortality from the fishery

Catch per unit effort figures were available from the Newfoundland trawler fishery from 1976-79. Only effort data from the stern trawlers was used since this comprised the major portion of the fishery. The catch per unit effort was applied to the total landings of all gears to arrive at total effort figures applicable to the stern trawlers (Table 2). The CPUE fluctuated over the past 4 yr with no apparent trend. The total effort appears to have been reasonably stable between 9.4 and 12.9 thousand hrs throughout the same period.

In order to obtain some recent estimate of fishing mortality the catch numbers at age were broken down into a standard CPUE at age based upon effort derived from the trawler fishery (Table 2). From this, Paloheimo Z's were calculated between years for what appeared to be the fully recruited age groups. The values derived for 1976-77 of F=0.56 and between 1978-79 of F=0.70 for ages 13+ appear reasonable, however, the value for 1977-78 of F=0.27 for ages 17+ would not seem to be of much use. A natural mortality of M=0.2 was assumed in all cases.

Average lengths at age from the commercial catches

For the years 1976-79, the average lengths at age were calculated from the commercial sampling statistics for each year separately. Since the computer

program breaks down the catch by sex, the average lengths at age were calculated separately (Table 3). For both sexes, it can be seen that the growth rate has increased from 1976 to 1979 for both sexes. This is apparent particularly in the fully recruited age groups and the groups which make up the bulk of the commercial landings (Table 3, Fig. 1).

Average weights in grams at age were then calculated for 1976 and 1979 and the difference between the two years is presented in Table 3.

An appreciable difference in average weight at age is apparent in fully recruited age groups. It is suspected that the negative values in the younger age groups may reflect discarding of small fish and an overestimation of average size at age in the earlier years.

Trends in age composition from biomass surveys

During January of 1978, 1979 and 1980, stratified-random biomass surveys have been carried out in the Gulf of St. Lawrence by the research vessel Gadus Atlantica with special emphasis on Division 4R. The results of the 1978 and 1979 surveys were presented in Bowering (1979) and in order to be comparable, the 1980 survey presented here was adjusted to the mean numbers at age per set for the same strata and methods as described in the previous document. The comparable results of the 1980 survey are presented in Table 4.

For comparison, the results of the three surveys are presented in Table 5 and Figures 2 and 3. The trends here tend to be similar to those shown in the commercial catch statistics with large reductions in numbers in the older age groups. Fish beyond 14 years old did not even occur in the catches for the 1980 survey. The total numbers caught per set were very similar for 1978 and 1979, however, the numbers for 1980 are less than half the 1979 values (Table 5).

Cohort analysis

While the series of commercial catch data was short, nevertheless, an attempt was made at running a cohort analysis. The numbers at age used in the analysis were those calculated in Table 2 assuming it was run from ages 6-21 with sexes combined. For the ages where no fish were caught, a value of one was substituted in order to allow the calculations to proceed.

Average weights

From the average lengths at age presented for each year in Table 3 a mean average length was calculated of 1976-78 combined. These lengths as well as the average lengths for 1979 were applied to a weight-length equation from Bowering (1976) and were used to calculate the biomass in the analysis for 1976-79. The average weights computed for 1979 were used later in future catch projections. All values are shown in Table 3.

Terminal F.

This presented the most difficulty since the data series for effort and numbers at age were too short to calculate any reliable relationship between fishing mortality and fishing effort. Consequently, the only available estimate of fishing mortality in the last year was that derived from the Palaheimo Z computed between 1978 and 1979 commercial catch numbers presented in Table 2. A value of $F=0.70$ was therefore used to initiate the calculations.

Partial recruitment

In order to derive a partial recruitment vector a comparison was made between the research vessel data and the commercial data in the most recent year ie:1979. The total population numbers from the survey was considered to be representative of the population structure as a whole and the percentage age composition was derived considering age 6+ to be 100% since age 6 was the age at first entry to the commercial fishery (Table 6). The commercial catch numbers were broken down in a similar fashion.

The ratios between the percentage at age for the commercial catch and the percentage at age for the research catch were calculated and these values were plotted in Fig. 4. A smooth curve was then drawn by eye through the points. From the actual curve, values were selected at each age and these were considered to be the relative partial recruitment values. It appeared that the fish were fully recruited at age 13 and levelled at this point. Age 13 and beyond was therefore given a partial recruitment value of one. The younger ages were given partial recruitment values in proportion to the relative partial recruitment value of age 13 (3.14). The partial recruitment vector used in the analysis is presented in the last column of Table 6.

It should be noted that the PR value for age 6 may be high since the survey gear is probably not selecting this age fish in high enough proportion as it actually is in the population.

Results of the cohort analysis at F_T=0.70 are presented in Table 7.

Yield per recruit

Using the average weights at age for the 1979 commercial catch (Table 3) and the partial recruitment vector for 1979 (Table 6) a yield per recruit curve was generated and presented in Fig. 5. The value of $F_{0.1}$ from yield per recurit curve was calculated as $F_{0.1}$ = 0.274.

REFERENCES

Bowering, W.R., 1976. Length-weight relationship in witch flounder, Glyptocephalus cynoglossus, in the Newfoundland area. ICNAF Research Bulletin No. 12.

Bowering, W.R., 1978. An analytical assessment of the witch flounder stock in the Gulf of St. Lawrence. (ICNAF Divs 4R and 4S). CAFSAC Research Document 78/7, 12 p.

Bowering, W.R. 1979. Current status of the witch fishery in the Gulf of St. Lawrence. (ICNAF Divs 4RS). CAFSAC Research Document 78/9, 17 p.

Table I. Witch landings Divisions 4RS

Year	4R	4S	Total
1970	3147	251	3398
1971	1996	132	2128
1972	550	402	952
1973	751	136	887
1974	2208	312	2520
1975	1664	281	1945
1976	3623	1718	5341
1977	1968	631	2599
1978	3429	866	4295[a]
1979	2858	358	3216[b]
			3439[c]

a - Revised January, 1980.

b - not including Maritimes

c - total catch from quota report(1979)

Table 2. Numbers caught at age for witch 4RS Commercial M+F based on revised catch statistics (Nos. in '000's)

Age	1976	c/1000 hr	1977	c/1000 hr	1978	c/1000 hr	1979	c/1000 hr
6	1	0.09	2	0.15	50	5.27	14	4.07
7	1	0.09	36	2.78	168	17.78	249	72.40
8	61	8.52	113	8.74	515	54.52	425	123.58
9	103	9.31	315	24.36	623	65.98	512	148.88
10	221	19.99	524	40.53	1196	126.70	1039	302.12
11	537	48.56	788	60.94	1213	128.54	1602	465.83
12	556	77.41	834	64.50	1372	145.40	1807	525.44
13	1055	95.41	844	65.27	1272	134.73	1266	368.13
14	936	84.64	796	61.56	986	104.44	249	72.40
15	588	53.17	351	27.15	496	52.55	131	38.09
16	475	42.96	199	15.39	270	28.58	29	8.43
17	207	18.72	100	7.73	152	16.07	1	
18	153	13.84	52	4.02	58	6.19	1	
19	55	4.97	15	1.16	9	0.92	1	
20	41	3.71	21	1.62	9	0.92	1	
21	47	4.25	8	0.62	1		1	
		F=0.56 13+			F=0.27 17+			F=0.70 13+
Total Catch	5341 tons		2599 tons		4295 tons		3439 tons	
Total Effort	11058 hrs.		12930 hrs.		9440 hrs.		10026 hrs.	
CPUE	0.483 tons/hr		0.201 tons/hr.		0.455 tons/hr		0.343 tons/hr.	

Table 3. Average Lengths for commercial witch in 4R

Age	1976 Feb.	1977 Feb.	1978 Jan.	1979 Jan.	Difference in $\bar{L}$ from 1976 to 1979(cm)	Difference in $\bar{W}$ from 1976 to 1979(gms)	Unweighted $\bar{L}$ for males + Females 1976-79	Unweighted $\bar{W}$ (kg) M+F 1976-79	Wtd $\bar{W}$ (kg) 1976(M +F)
MALE									
5			28.50	24.21			26.36	0.087	0.064
6		30.50	30.37	29.77			29.63	0.133	0.125
7		35.59	32.80	33.54			32.76	0.191	0.197
8	37.41	35.83	36.73	33.75	-3.66	-95.87	36.20	0.274	0.224
9	36.53	36.92	37.03	36.81	+0.28	+ 7.92	37.09	0.299	0.281
10	38.57	38.44	38.79	38.39	-0.18	- 5.78	38.59	0.345	0.328
11	39.16	38.13	39.54	40.10	+0.94	+32.58	39.97	0.392	0.398
12	40.42	39.78	41.36	41.91	+1.49	+57.04	41.57	0.452	0.490
13	42.36	40.52	42.55	46.25	+3.89	+180.68	43.64	0.538	0.653
14	43.16	42.23	44.12	48.97	+5.81	+299.22	45.85	0.644	0.952
15	43.03	44.55	45.24	48.50	+5.47	+276.86	46.88	0.697	1.037
16	43.93	47.86	47.92				48.58	0.793	1.185
17	51.07	49.50	48.92				50.05	0.883	
18	48.73	51.50	50.50				50.94	0.942	
19			52.50				53.01	1.087	
20							53.33	1.111	
21							54,56	1,207	
FEMALE									
6			31.02	26.50					
7		28.50	34.39	31.75					
8	36.50	37.31	36.48	35.58	-0.92	-24.88			
9	36.17	37.59	39.87	35.83	-0.34	- 9.17			
10	39.35	38.61	39.54	37.04	-2.31	-73.32			
11	41.22	39.91	41.54	40.18	-1.04	-38.65			
12	40.76	41.96	43.36	43.02	+2.26	+90.59			
13	42.88	43.83	44.76	45.99	+3.11	+145.49			
14	44.47	45.99	46.60	51.29	+6.82	+388.87			
15	44.82	47.70	48.64	52.52	+7.70	+458.62			
16	46.45	49.53	50.06	54.29	+7.84	+510.73			
17	49.42	49.60	51.79						
18	50.21	51.82	52.88						
19	51.65	52.58	55.30						
20	50.89	52.61	56.50						
21	54.20	53.83	55.64						

Table 4. Witch Gadus 31 1980 Division 4R Av. No./Set

MALE Age	STRATUM 801	802	809	810	811	812	813	Wtd. Mean No/Set
Area Sq. Miles	354	399	451	223	439	1355	1154	
3	0.33		0.33					0.06
4	0.67							0.05
5	1.34	0.33	2.07			0.06	0.25	0.44
6	0.87	1.58	5.52	0.13	0.03	0.79	0.69	1.22
7	0.47	3.02	3.46	1.19	0.37	0.65	0.29	1.05
8	0.56	3.36	2.28	1.05	0.10	0.39	0.35	0.86
9	1.26	6.58	2.62	2.38		0.25	0.15	1.21
10	3.09	10.93	2.60	3.56	0.18	0.20	0.03	1.78
11	1.07	3.31	0.87	1.65	0.07			0.57
12	0.33	0.56	0.24	0.29				0.12
FEMALE								
3	0.50						0.19	0.05
4	1.58	0.10	0.10				0.71	0.33
5	2.25	0.69	2.80	0.16		0.01	0.49	0.67
6	1.13	1.91	5.04	0.64		0.11	0.33	0.94
7	0.18	4.14	2.38	1.34	0.13	0.25	0.05	0.81
8	0.41	3.19	1.01	0.89	0.13	0.18	0.02	0.55
9	1.22	6.61	1.65	1.56	0.13	0.15	0.12	1.04
10	1.47	13.36	4.08	3.33	0.15	0.55	0.10	2.14
11	1.39	15.05	3.47	2.62	0.52	0.69	0.26	2.31
12	0.38	5.62	0.93	1.02	0.31	0.04	0.24	0.80
13		0.66	0.23	0.68	0.13			0.13
14				0.25				0.01

Table 5. Wtd. Mean No./Set from January Surveys in Division 4R

MALE

Age	1978	1979	1980
3	0.10		0.06
4	0.25	0.03	0.05
5	0.62	0.33	0.44
6	1.66	0.35	1.22
7	1.74	1.13	1.05
8	1.59	1.60	0.86
9	2.71	1.59	1.21
10	3.62	4.18	1.78
11	1.86	4.12	0.57
12	3.43	2.84	0.12
13	1.04	0.73	
14	0.21		
15	0.07	F=0.82	
		8+	
Total	18.90	16.90	7.36

FEMALE

3	0.29	0.05	0.05
4	0.49	0.07	0.33
5	0.31	0.49	0.67
6	1.91	0.45	0.94
7	1.34	1.13	0.81
8	0.60	1.33	0.55
9	1.19	1.99	1.04
10	1.76	2.32	2.14
11	2.06	3.93	2.31
12	3.02	6.34	0.80
13	2.77	2.75	0.13
14	1.78	0.82	0.01
15	0.86	0.61	
16	0.18	0.04	
17	0.06		
18	0.02		
		F=2.42	
		12+	
Total	18.64	22.32	9.78

Table 6. 1979 Partial Recruitment 4Rs witch (sexes combined)

AGE	1979 Popn Nos.'000's from Survey	% 6-16	1979 Comm Catch Nos.	% 6-16	Relative Partial Recruitment	Partial Recruitment
3	69					
4	186					
5	604					
6	457	2.92	14	0.19	0.07	0.028
7	1268	8.10	117	1.60	0.20	0.062
8	1534	9.80	344	4.69	0.48	0.107
9	1441	9.20	403	5.50	0.60	0.140
10	2655	16.95	600	8.19	0.48	0.207
11	2777	17.73	1368	18.66	1.05	0.317
12	3640	23.24	1968	26.85	1.16	0.467
13	1309	8.36	1924	26.25	3.14	1.00
14	424	2.71	410	5.59	2.71	1.00
15	130	0.83	146	1.99	3.27	1.00
16	26	0.17	36	0.49	2.88	1.00
Total 6-16	15661		7330			

Table 7.

WITCH 4RS M+F

NATURAL MORTALITY= 0.20

PARTIAL RECRUITMENT MULTIPLIER

0.0280	0.0620	0.1070	0.1400	0.2070	0.3170	0.4670	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

ASSUMED FISHING MORTALITY FOR LAST AGES

0.4000	0.4000	0.4000	0.7000

ESTIMATED POPULATION

AGE	YEAR 1976	1977	1978	1979
6	11907.	9911.	7950.	796.
7	16629.	9748.	8112.	6464.
8	18589.	13613.	7948.	6490.
9	15779.	15164.	11044.	6042.
10	8568.	12825.	12130.	8478.
11	4799.	6815.	10026.	8849.
12	4228.	3444.	4866.	7111.
13	3173.	2687.	2065.	2743.
14	1957.	1643.	1436.	539.
15	1173.	756.	625.	284.
16	760.	428.	301.	63.
17	318.	192.	171.	2.
18	208.	73.	67.	2.
19	94.	32.	13.	2.
20	78.	27.	13.	2.
21	156.	27.	3.	2.

KNOWN CATCHES

AGE	YEAR 1976	1977	1978	1979
6	1.	2.	50.	14.
7	1.	36.	168.	249.
8	61.	113.	515.	425.
9	103.	315.	623.	512.
10	221.	524.	1196.	1039.
11	537.	788.	1213.	1602.
12	856.	834.	1372.	1807.
13	1055.	844.	1272.	1266.
14	936.	796.	986.	249.
15	588.	351.	496.	131.
16	475.	199.	270.	29.
17	207.	100.	152.	1.
18	153.	52.	58.	1.
19	55.	15.	9.	1.
20	41.	21.	9.	1.
21	47.	8.	1.	1.

ESTIMATE FISHING MORTALITY

AGE	YEAR 1976	1977	1978	1979
6	0.0001	0.0002	0.0070	0.0
7	0.0001	0.0041	0.0232	0.0
8	0.0036	0.0092	0.0743	0.0
9	0.0072	0.0232	0.0644	0.0
10	0.0289	0.0462	0.1154	0.0
11	0.1320	0.1367	0.1435	0.0
12	0.2533	0.3115	0.3734	0.0
13	0.4581	0.4264	1.1421	0.0
14	0.7518	0.7667	1.4215	0.0
15	0.8074	0.7203	2.0972	0.0
16	1.1750	0.7204	4.7341	0.0
17	1.2729	0.8568	4.1664	0.0
18	1.6737	1.5553	3.2277	0.0
19	1.0385	0.7313	1.5600	0.0
20	0.8733	1.9044	1.5600	0.0
21	0.4000	0.4000	0.4000	0.7000

TOTAL F AGES 10 TO 20

1976	1977	1978
0.2528	0.1898	0.2812

POPULATION WTS AND NOS

	1976	1977	1978	1979
WT	26560.	23802.	21357.	16615.
NO	88415.	77384.	66770.	47869.

POPULATION WTS AND NOS AGE 10 TO 21

	1976	1977	1978	1979
WT	11990.	12358.	13270.	11690.
NO	25512.	28948.	31716.	28078.

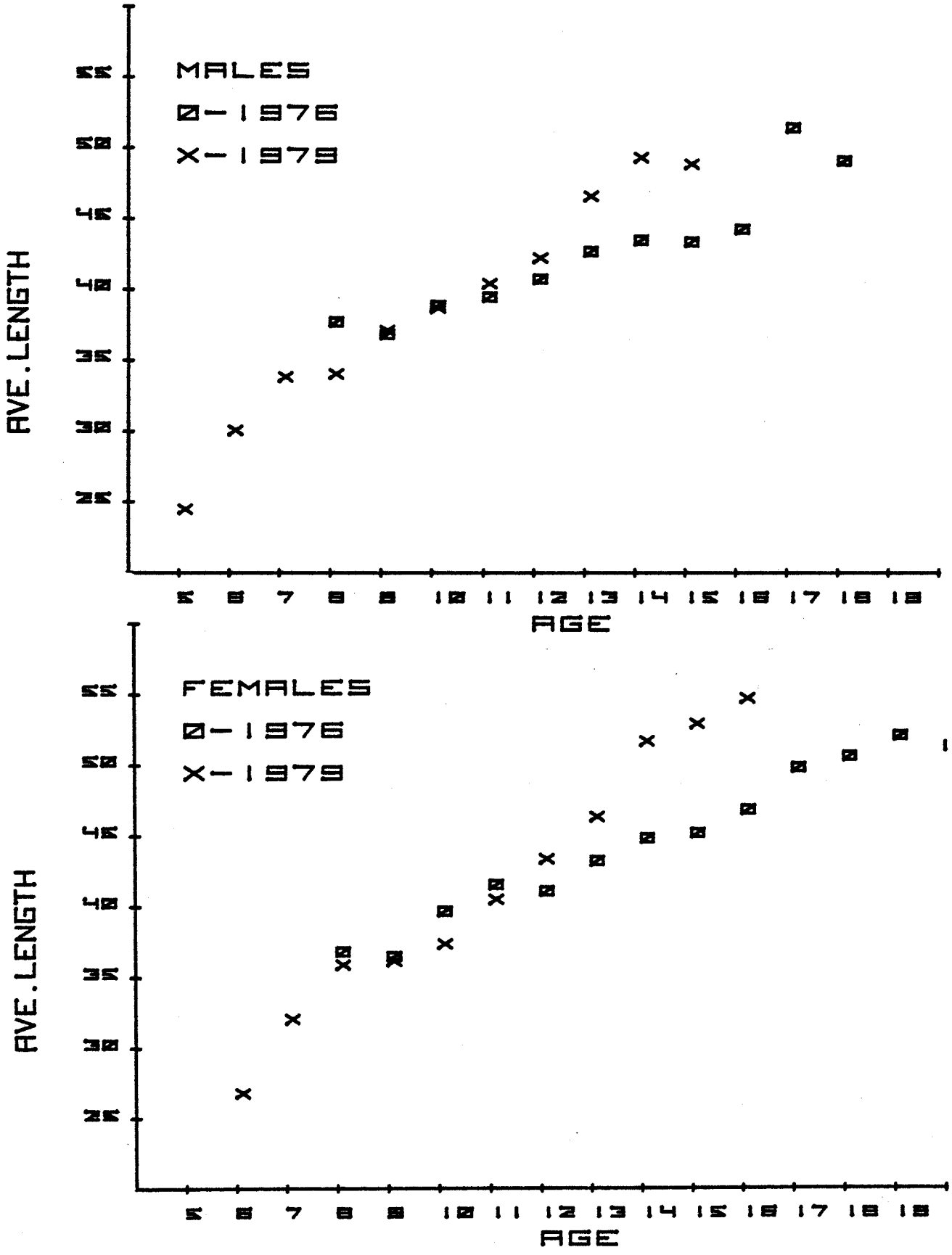

Figure 1. Age-length plots for commercial witch in Division 4RS.

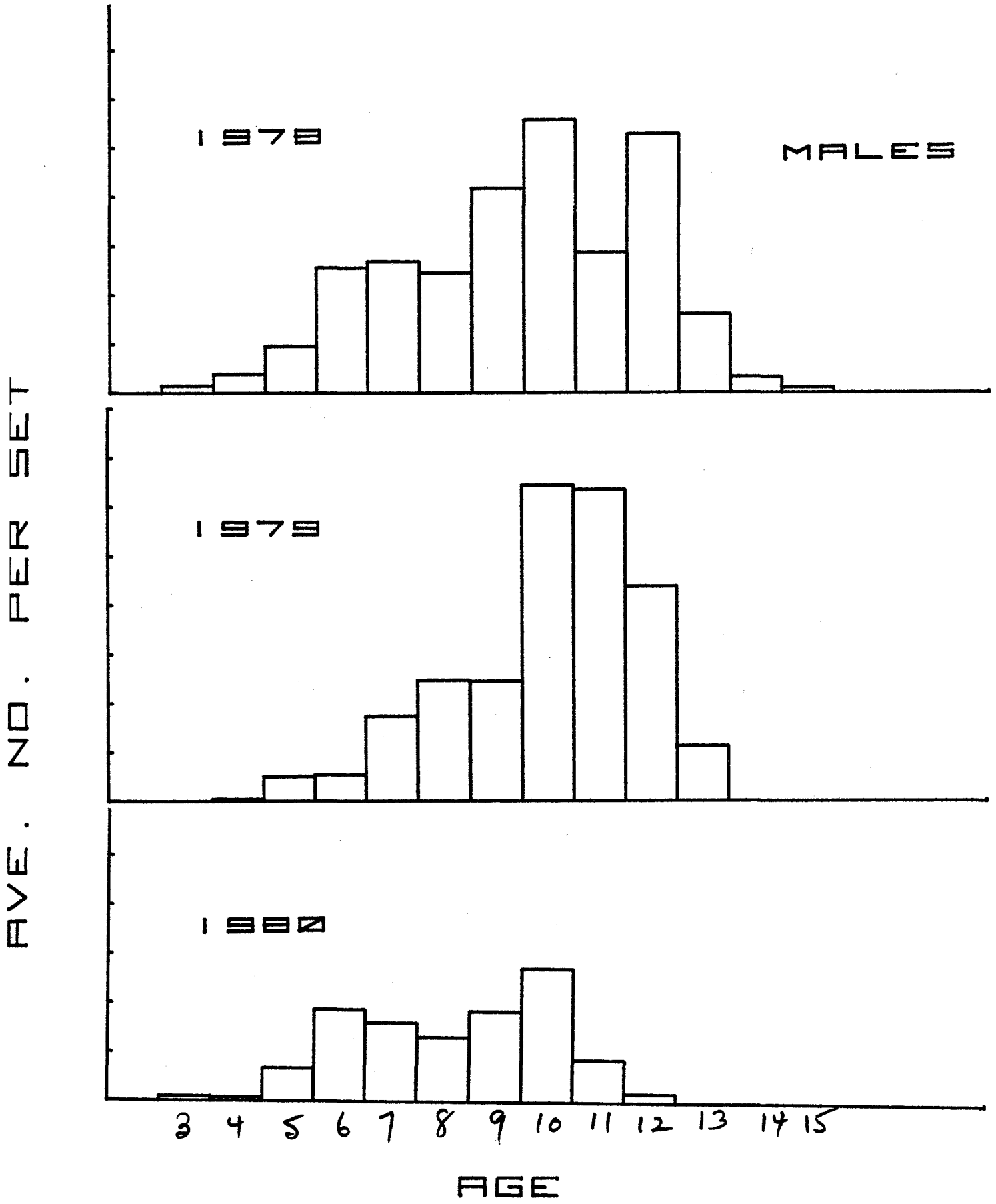

Figure 2. Average number of male witch per set by age from Gadus Atlantica research surveys in Divs. 4RS.

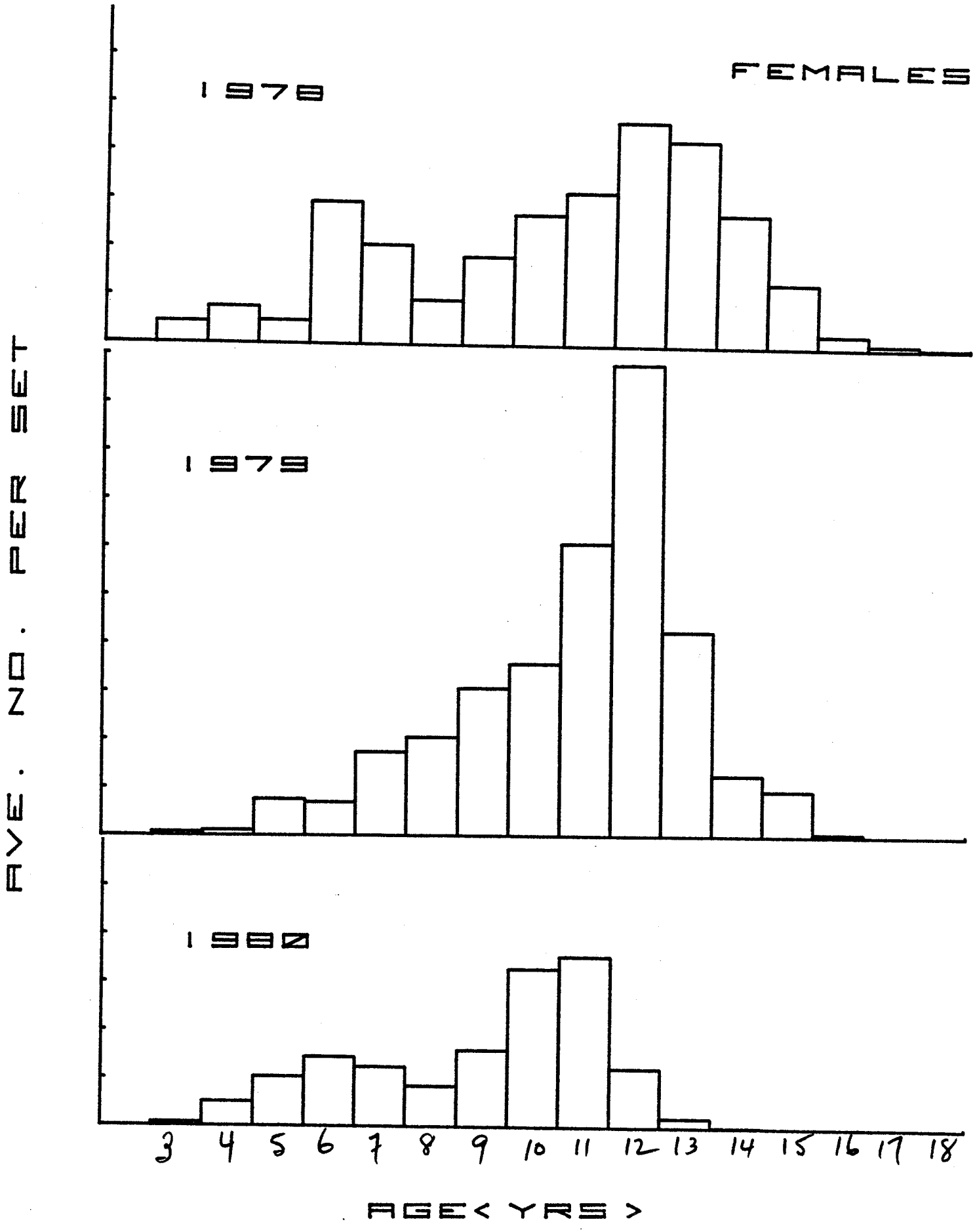

Figure 3. Average number of female witch per set by age from Gadus Atlantica research surveys in Divs 4RS

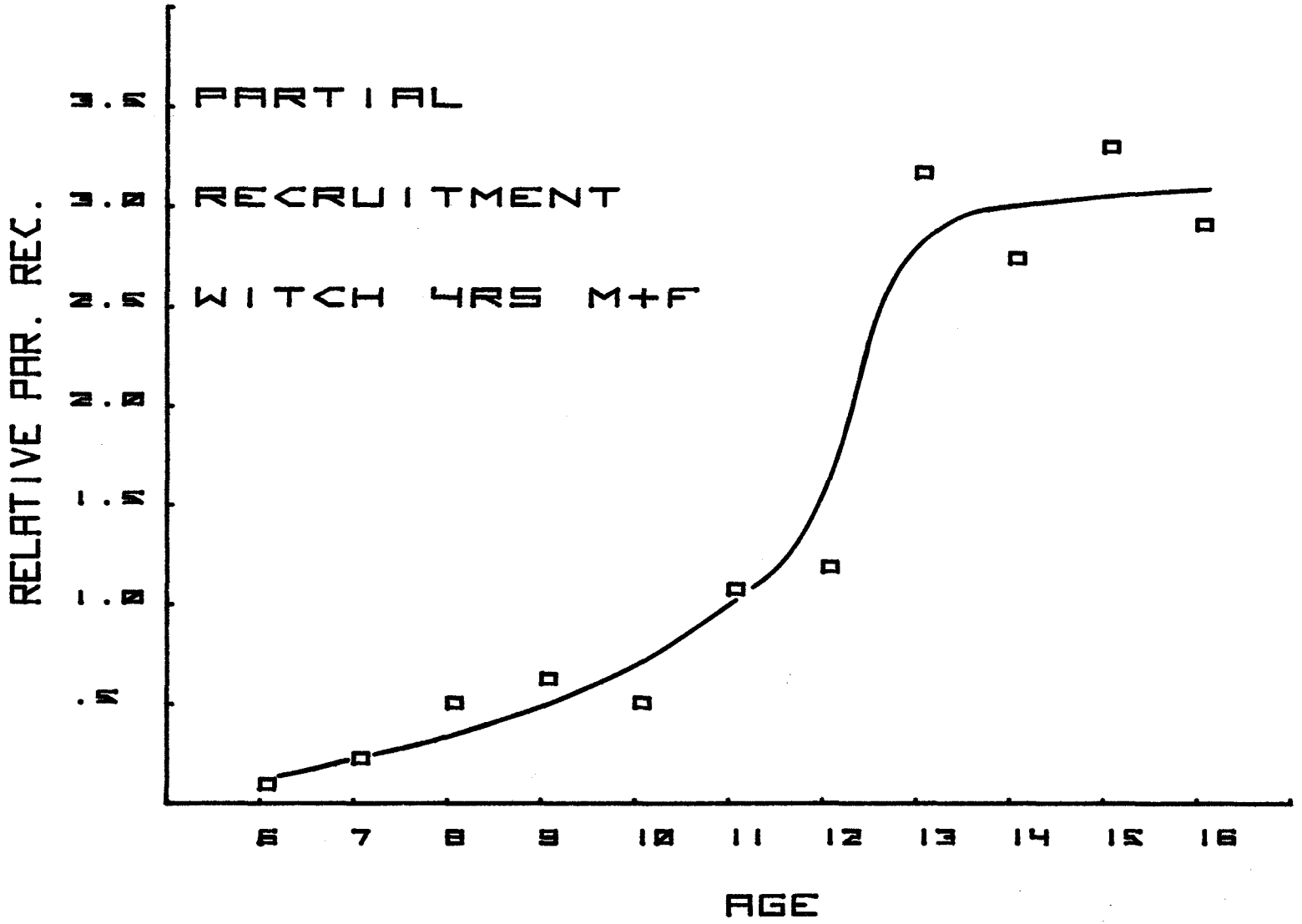

Figure 4. Ratio of percent-at-age for commercial catch and percent-at-age for research catch plotted against age for witch in Divs 4RS.

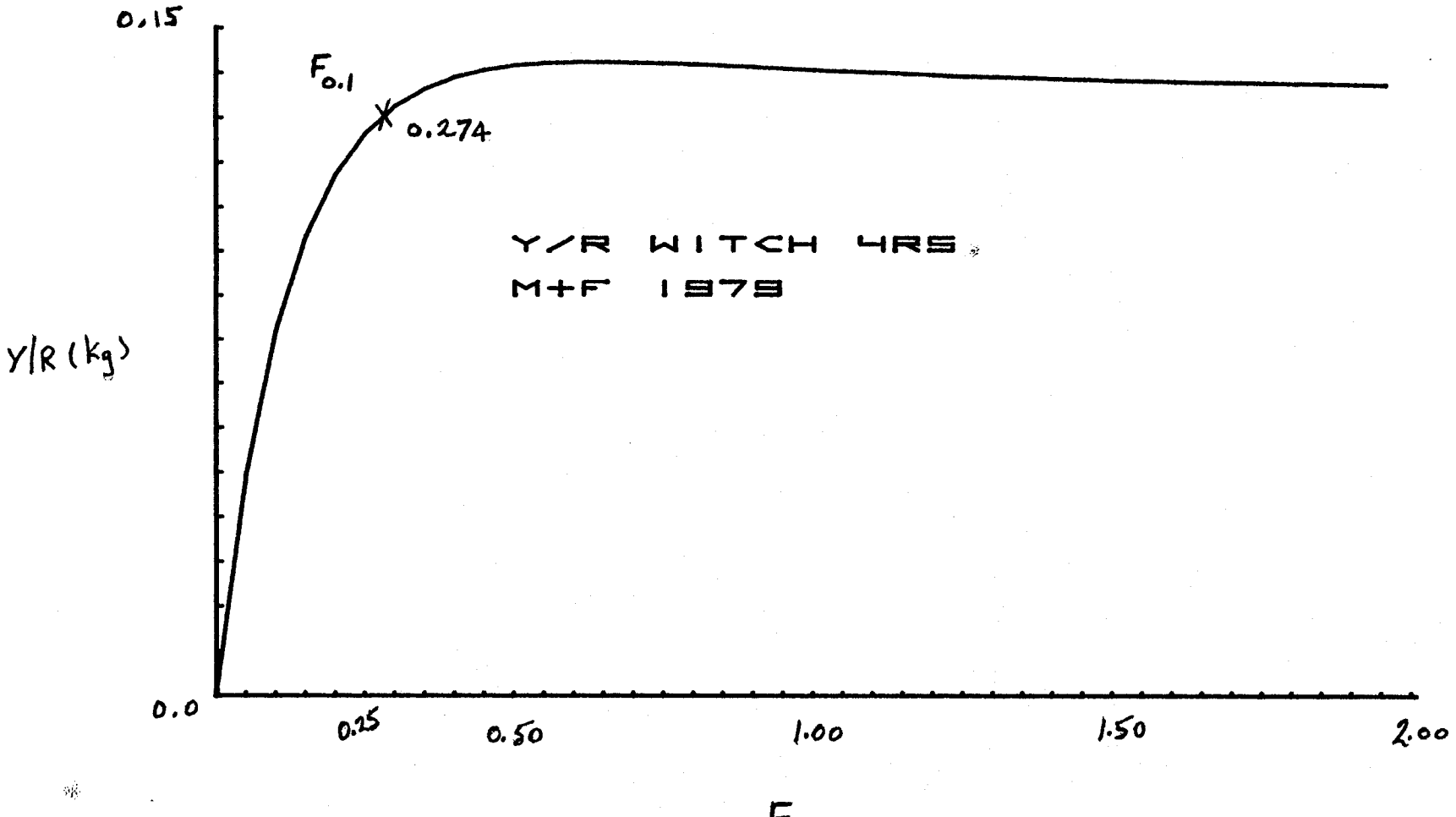

Figure 5. Yield per recruit curve for witch in Divs 4RS.