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Analytical and Acoustic Assessments of the Capelin Stock in Subarea 2 and Div. 3K, 1979

by

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Introduction

In 1972, substantial catches of capelin were made in NAFO Div. 2J3K and since that time an important capelin fishery has occurred in that area. Catches have declined in recent years due to poor recruitment (ICNAF Summ. Doc. 79/5). This paper presents results of an analytical analysis of the stock using a sequential capelin abundance model 2J3K (SCAM 2J3K) developed by Miller and Carscadden (1979) and the results of an acoustic biomass estimate calculated from a survey in the autumn of 1979.

Fishery Trends and Regulation of the Fishery

The first large offshore capelin catches from NAFO Subarea 2 + Div. 3K were reported in 1972. Catches rose rapidly, peaked in 1976 at 216,300 tons and have declined since then to approximately 9,800 tons in 1979 (not including the inshore Canadian catch). This stock first came under quota regulation in 1974 when a TAC of 110,000 tons was recommended. This was increased to 300,000 tons in 1975 and remained at that level through 1978. Evidence of poor recruitment in this capelin stock resulted in a reduction in the TAC in 1979 to 75,000 tons.

Analytical Assessment

The basic model used in this analysis is the same as that presented in Miller and Carscadden (1979).

Numbers-at-age and Mean Weight-at-age

Numbers-at-age for 1972-77 inclusive were obtained from USSR sampling data (Seliverstov, pers. comm.). During 1978 and 1979, Canadian observers on foreign vessels have sampled capelin catches and numbers-at-age for these years were derived from these sampling data (Table 1).

Mean weight-at-age for 1972-77 also was from USSR sampling data (Seliverstov, pers. comm.) and for 1978 and 1979 from sampling data collected by Canadian observers on foreign vessels. Mean weights for males and females were combined by weighting by catch-numbers (Table 2). Mean weight-at-age for the start of the year was obtained by applying the mean weight-at-age from the fall fishery to the next oldest age in the next year (Table 2). For example, the weight for a 2-year-old fish in the fall of 1973 would be the weight of a 3-year-old at the beginning of 1974.

Spawning Mortality

Two data sources were used to provide estimates of spawning mortality.

From Winters and Campbell (1974) an estimate of Z at each age was calculated for sexes combined by weighting by the sex ratios found in Table 4. This yielded the following values of Z:

Age	Z
3-4	0.73
4-5	2.11
5-6	2.23

Using USSR catch-at-age data from 3L (Bakanev, pers. comm.), the per mille age-composition was calculated with sexes combined. The assumption was made that the catches were predominantly mature fish. It was assumed that the maturation rate was equivalent to the recruitment rate (Winters and Campbell 1974) and using the values of % mature-at-age by these authors in their Table 6, the mean relative number of fish in each age-group was calculated. Values of Z calculated from these data are:

Age	Z
3-4	0.60
4-5	1.17
5-6	2.83

The values of Z from the USSR and Canadian data were then combined to give the following values:

Age	Z
3-4	0.67
4-5	1.64
5-6	2.53

Spawning mortalities (SM) were calculated using the formula $Z = M - \ln (pe^{-SM} + (1-p))$ from Carscadden and Miller (1979). The value of M was 0.3 and values for p were from Table 6 of Winters and Campbell (1974). This calculation resulted in the following values for spawning mortality:

Age	Spawning Mortality
3	1.39
4	1.69
5	2.23

The value of 2.23 was also used as the spawning mortality for age 6.

Estimation of p

Relative estimates of p, the proportions mature at age, were estimated by comparing length of the year-class with a maturity ogive. An example of the method is given for age 3 and the same procedure was used for all age-classes.

The length of 2+ capelin in the commercial fishery was estimated using mean weights from USSR sampling data (Seliverstov, pers. comm.). The length-weight relationships are given by:

$$\text{Male: } \ln l = 2.088 + 0.230 \ln W$$

$$\text{Female: } \ln l = 2.037 + 0.250 \ln W$$

These expressions are derived from Canadian data collected during November, 1967-77. These lengths were then compared to the mean lengths of 3-year-old mature capelin collected from spawning beaches in 3K the following

year. Assuming that the fish in the fishery are maturing, the differences in length should represent the growth between the fall and spawning season (Table 3).

The lengths of fish at age 2+ (Nov.) from Pack's Harbour, Labrador and Notre Dame Bay were estimated using von Bertalanffy growth equations (Winters 1974). These estimates were averaged for males and females. The estimates of growth from Table 3 were then added to these calculated lengths to give an estimate of relative length of each year-class (Table 4). These estimates were then compared to maturity ogives for capelin (Carscadden 1978) to provide relative estimates of p by sex. An estimate of p for sexes combined (Table 5) was calculated by weighting the estimates by sex by the numbers of males and females of that year-class in the fall fishery. This process of estimating p was repeated for all age-classes (Table 6).

An examination of the values of age 3 suggested that the value for p normally was below 0.2 except for 1974 and 1979. Few data were available for younger fish in the early part of the inshore data series and as a result the value from 1974 was considered to be an over-estimate. Since it was felt that the values for 1974-78 were more reliable, the average value for these years was used for 1974 and 1972 for which no data were available. No changes were made in 1979 or in the older age-classes. The estimates of p for ages 4, 5, and 6 in 1972 were averages of 1973-79 values.

Partial Recruitment

Estimates for partial recruitment were derived from a comparison of the relative age composition of 2+ fish and older in the fishery to that collected from research fishing sets on the acoustic survey (Table 7).

Fishing Mortality

A number of runs of SCAM were made with starting fishing mortality ranging from 0.001 to 0.700. Regressions were calculated using capelin biomass on Sept. 1., the start of fishing, and catch-per-hour of USSR BMRT-A trawlers (Seliverstov and Serebrov 1979) for the years 1973-78 (Table 8).

The 1979 value of catch-per-hour was derived from USSR sampling data. The 1972 values were not included in the regression because of possible inexperience of the Soviet fishing fleet, resulting in an underestimate of catch-per-effort. The best fit occurred with a fishing mortality of F = 0.012 (Fig. 1). Details of the run of the SCAM model for this value of F are given in Tables 9 and 10.

The biomass on Sept. 1, 1979, estimated in the SCAM is 2,790,000 tons, substantially higher than the biomass estimated for 1978. However, the 1979 biomass predicted from the regression using 1.34 as a value for catch-per-hour is 477,400 metric tons. The estimate for the SCAM is highly dependent on the partial recruitment factors used, especially for age 2+. An examination of the catch data and the research survey data would suggest that the partial recruitment factor is in error. The catch data suggests that there was strong selection by the fishery on the 2+-year-olds. In addition, during the acoustic survey, relatively few schools of capelin were encountered and consequently the numbers of samples taken were small. Thus, the sampling data could also be biased. It is probable that the selection factor on the age 2 fish should have been much higher and possibly higher than the selection factor used for the older age-classes. The predicted value from the regression probably reflects more accurately the general trend in the biomass of capelin over the last few years.

Using the predicted biomass estimate of 477,400 metric tons on Sept. 1 and accepting the biomasses predicted for ages 3+ and older would suggest that there were 301,000 tons of 2+ capelin available in Div. 2J3K in the fall of 1979. This corresponds to 14,976,000 x 10^3 individuals in Sept. 1979 and 18,291,700 individuals on Jan. 1, 1979.

An examination of the trends in year-class strength from Table 9 reveals that the 1973 year-class is very strong. The 1974 year-class is also relatively strong whereas the 1969 year-class is only moderately strong. This latter observation does not agree with the sampling data which suggests that the 1969 and 1973 year-classes were the strongest in recent years. This discrepancy may have occurred because of incorrect estimates of p, especially in the early years of the data series. For instance, we used average values of p for 1972 and our inshore sampling data was relatively poor in 1973 and 1974. Thus, it would seem that the 1969 year-class is underestimated; it is also possible that the 1974 year-class has been over-estimated. If these assessments are true, then the biomass during the fishery in 1972 should be substantially higher and biomasses during the fishery since 1976 should be lower.

A comparison of age compositions of mature capelin collected on spawning beaches in Div. 3K and mature age compositions predicted from SCAM was made (Table 11). There is reasonable agreement during the early years of the model 1973-75 but discrepancies occur from 1976 to 1979. These discrepancies can be partially explained by over-estimation of the 1974 year-class in the SCAM. For instance, the 1974 year-class appears relatively stronger as 3- and 4-year-olds in results from SCAM than from the inshore sampling data.

Acoustic Survey Results

An acoustic survey was conducted in NAFO Div. 2J and 3K by the Canadian research vessel Gadus Atlantica between October 24-November 12, 1979. Fig. 2 and 3 show the survey track and relative capelin density estimates for 2J and 3K, respectively. Table 12 gives relative density estimates for capelin in 2J and 3K from the acoustic surveys, areas sampled and relative biomass estimates for each area. Comparable relative estimates for 1978 and 1977 (Miller and Carscadden 1979) are also included. The 1977 and 1978 results have been reduced by a factor of 12.2 to account for an error in the integration algorithm that was corrected in 1979. Fig. 4 shows MWT fishing sets made during the survey and % capelin by weight in each set. Arctic cod were very abundant in both 2J and 3K and constituted the largest portion of the pelagic biomass. Fig. 5 shows age-composition by number of capelin sampled by midwater trawl during the survey and for comparison, the age-composition for the commercial fishery. Fig. 6 indicates age-composition by weight of the biomass estimates for 1977, 1978 and 1979.

A target strength of -54.1 dB was used for capelin in Div. 3K. This value was derived from a regression of T.S. versus $\bar{W}$ for capelin (Buerkel, pers. comm.). In Div. 2J, arctic cod were the most abundant species observed during the survey. To account for this, a pelagic biomass estimate was made using weighted target strength of -48.4 dB based on capelin-arctic cod proportions. Individual capelin and arctic cod T.S. values were derived from T.S.-length regression for cod and capelin (Dalen et al. 1976) corrected for aspect angles distribution (Nakken and Olsen 1977). Research fishing sets in 2J indicated 7.2% of pelagic biomass sampled was capelin. This value was used to apportion that part of the total pelagic biomass that could be considered to be capelin.

There is a high degree of uncertainty about estimated target strength values used in these acoustic surveys. The target strength of any fish is highly dependent on such factors as size of fish, condition factor, and tilt angle. Although there have been numerous laboratory experiments performed to determine the target strengths of fish (Nakken and Olsen 1977; Dalen et al. 1976; Goddard and Welsby 1977; Haslett 1977), until these estimates can be related to research into behavioral traits such as swimming angle of fish, the true variance about this parameter cannot be estimated. Consequently, biomass estimates from these surveys should be considered to be relative estimates only.

DISCUSSION

Results from both the analytical and acoustic assessment of capelin in NAFO Div. 2J3K in 1979 indicate that a substantial decrease in capelin biomass

occurred in recent years. The catch-per-unit-effort data from the commercial fishery also suggest a decline in capelin abundance. Since acoustic surveys were not started by Canada until 1977, we have compared only the last 3 years of both methods.

	Relative Abundance		
	1977	1978	1979
SCAM	1	0.15	0.11
Acoustic	1	0.33	0.22

This comparison suggests that in 1978 capelin abundance declined to about 1/3 - 1/6 of the 1977 level and in 1979 it declined to about 1/5 - 1/10 of the 1977 level. Furthermore, the SCAM results would suggest that the 1979 biomass was only about 7% of the peak biomass which occurred in 1976.

The decline in biomass in recent years appears to be largely a result of poor recruitment. The 1973 year-class was large and made significant contributions to the total biomass in 1975, 1976, and 1977. The results of the SCAM also indicated that the 1974 year-class was also good but as discussed previously, the size for this year-class appears to be over-estimated. The sizes of the 1975 and 1976 year-classes at age 2+ estimated from SCAM are very low, being only about 3% of the large 1973 year-class and about 6% of the average of the year-classes from 1970-74. The decline in recruitment in recent years is apparent in the age-compositions from 1979; older fish are low in abundance while the 1977 year-class made a significant contribution to both research and commercial catches. In spite of this observation the 1977 year-class appears to be extremely weak.

No estimate of the size of the 1978 year-class is available. Although 1-year-olds composed a high proportion of the research vessel catches this fact should be treated with caution since older age-classes were relatively low in abundance.

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ADDENDUM

In the regression of biomass on Sept. 1 and catch per hour, the 1972 point was omitted because of possible bias in the catch per effort figure due to inexperience of the Soviet fleet. If this point is included in the calculation, the highest r^2 value occurs with $F_T = 0.010$ (Fig. 7). Results of the SCAM are given in Tables 13 and 14). When C/E for 1979 is 1.34 the biomass predicted for Sept. 1, 1979 is 1,061,440 metric tons. Assuming that the older age-groups are accurately calculated, then the biomass of the 1977 year-class at age 2 is 850,094 tons which corresponds to 42,293,200 x 10^3 individuals on Sept. 1 and 51,657,100 x 10^3 individuals on Jan. 1, 1979.

This analysis agrees with the other assessment presented in this paper in that the 1973 year-class was the strongest, followed by the 1974 and 1969 year-classes.

Table 1. Numbers-at-age of capelin in catch in Div. 2J3K, 1972-79.

	Year							
Age	1972	1973	1974	1975	1976	1977	1978	1979
2	228420	1306440	1015200	5553990	789650	157010	247465	355482
3	1240140	1538840	2463850	2486910	7409420	1578100	842792	47307
4	406380	2085270	888120	733280	605650	3170380	574832	11022
5	54670	262150	616150	164790	77350	328780	518080	15448
6	7180	14230	49280	42960	16280	45070	28298	14221

Table 2. Mean weights (g) of capelin at age at beginning of the year (Jan. 1) and during fishing, 1972-79.

Jan. 1

	Year							
Age	1972	1973	1974	1975	1976	1977	1978	1979
2	8.800	8.800	8.800	9.600	8.800	9.500	8.400	8.800
3	14.600	16.900	19.800	19.200	17.300	12.800	21.300	14.700
4	23.100	23.600	26.900	25.400	28.700	24.800	26.200	19.800
5	26.900	25.900	29.200	29.000	32.400	31.500	29.900	24.900
6	30.000	26.100	30.200	28.400	32.500	38.200	32.400	27.700

During Fishing

	Year							
Age	1972	1973	1974	1975	1976	1977	1978	1979
2	16.900	19.800	19.200	17.300	12.800	21.300	14.700	20.100
3	23.600	26.900	25.400	28.700	24.800	26.200	19.800	24.400
4	25.900	29.200	29.000	32.400	31.500	29.900	24.900	27.900
5	26.100	30.200	28.400	32.500	38.200	32.400	27.700	31.600
6	25.500	31.700	30.400	31.900	43.700	38.000	32.000	34.700

Table 3. Estimated length of age 2+ capelin by sex from fall fishery, mean length of mature 3-year-olds by sex from capelin spawning inshore in Div. 3K and estimated growth by sex of the year-class between the fall and the spawning season.

	Males		
Year-class	Calculated length (mm) of age 2+ - fall fishery	Mean length (mm) of mature fish (age 3)	Growth (mm)
1969	151	-	
1970	147	181	34
1971	163	187	24
1972	167	188	21
1973	161	183	22
1974	155	180	25
1975	165	180	15
1976	150	175	25
	Females		
1969	148	-	
1970	157	165	8
1971	157	178	21
1972	153	165	12
1973	152	161	9
1974	144	154	10
1975	160 (147)*	155	8
1976	146	159	13

* the value of 147 was estimated using Canadian sampling data.

Table 4. Back-calculated length (mm) in Nov., age 2+ capelin by sex, estimated growth of the year-class (from Table 3) by sex and relative length of the year-class by sex.

Year-class	Length (Nov., age 2+) from back-calculation	Growth	Estimated length (age 3)
	Males		
1969	136	-	160*
1970	136	34	170
1971	136	24	160
1972	136	21	157
1973	136	22	158
1974	136	25	161
1975	136	15	151
1976	136	25	161
	Females		
1969	124	-	136*
1970	124	8	132
1971	124	21	145
1972	124	12	136
1973	124	9	133
1974	124	10	134
1975	124	8	132
1976	124	13	137

* average of year-classes 1970-76.

Table 5. Estimates of p, proportions of mature capelin at age 3, males and females combined.

Year	p
1972	.22
1973	.15
1974	.39
1975	.18
1976	.15
1977	.12
1978	.09
1979	.45

Table 6. Estimates of p for capelin by age, 1972-73, calculated by the back-calculation-maturity ogive method. The value for p, age 2, was assumed to be 0.0. Where two values occur, the value in the numerator is the value used in the model and the value in the denominator is the value actually calculated.

	Year							
Age	1972	1973	1974	1975	1976	1977	1978	1979
2	0	0	0	0	0	0	0	0
3	.14	.15	$\frac{.14}{.39}$	.18	.15	.12	.09	.45
4	.92	.88	.98	.96	.92	.87	.97	.87
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 7. Comparison of percent age-composition of capelin (age 2+ and older) from commercial fishery and research vessel surveys, NAFO Div. 2J3K.

	Age				
Source	2	3	4	5	6
Commercial	80.2	10.7	2.5	3.5	3.2
Research	94.2	3.2	1.0	1.0	0.7
Ratio of Commercial Research	.85	3.3	2.5	3.5	4.6
Partial Recruitment Factors	0.24	1	1	1	1

Table 8. Estimates of catch (tons) per hour of USSR BMRT-A trawlers in the 2J3K capelin fishery. Values from 1972-78 from Seliverstov and Serebrov (1979) and 1979 value from USSR sampling data.

	Year							
	1972	1973	1974	1975	1976	1977	1978	1979
Catch/hour	2.81	3.29	4.56	6.47	5.27	4.14	2.29	1.34

Table 9. Total numbers-at-age ($x10^{-3}$), total biomass (metric tons), mature numbers-at-age ($x10^{-3}$), mature biomass (metric tons) for NAFO Div. 2J3K capelin, Jan. 1 of each year, 1972-79, starting F = 0.012.

TOTAL POPULATION AT START OF YEAR

YEARS AGE	1972.	1973.	1974.	1975.	1976.	1977.	1978.	1979.
2	102084549.	123378277.	119561966.	289745322.	211026548.	9741955.	10694538.	158647270.
3	124849544.	75408357.	90158603.	87608231.	209368924.	155580652.	7067762.	7687472.
4	62662732.	81588105.	48108648.	57426171.	53764418.	130590094.	103370509.	4081668.
5	3302211.	11207517.	15086923.	6314001.	8540458.	9372120.	25096239.	15456820.
6	118675.	211162.	644174.	619195.	346763.	606866.	435352.	1507657.
BIOMASS	4261046.	4581395.	4591400.	6122949.	7310135.	5641019.	3713168.	2016555.

MATURE POPULATION AT START OF YEAR

YEARS AGE	1972.	1973.	1974.	1975.	1976.	1977.	1978.	1979
2	.	.	.	.	.	.	.	.
3	17478934.	11311254.	12622203.	15769482.	31405340.	18669679.	636099.	3459362.
4	57649711.	71797532.	47146476.	55129126.	49463262.	113613383.	100269397.	3551051.
5	3302211.	11207517.	15086923.	6314001.	8540458.	9372120.	25096239.	15456820.
6	118675.	211162.	644174.	619195.	346763.	606866.	435352.	1507657.
BIOMASS	1679290.	2181368.	1978152.	1903745.	2250888.	3374988.	3405090.	547800.

Table 10. Numbers-at-age ($x10^{-3}$) and biomass (metric tons) on Sept. 1 and total fishing mortality rates for NAFO Div. 2J3k capelin, 1972-79, starting F = 0.012.

TOTAL POPULATION-START OF FISHING (SEPT 1)

YEARS AGE	1972.	1973.	1974.	1975.	1976.	1977.	1978.	1979.
2	83579760.	101013589.	97889059.	237223406.	172773924.	7976038.	8755947.	129889399.
3	91472022.	54784923.	66055425.	62032394.	152108612.	115900449.	5395518.	4167136.
4	12813560.	18862426.	7910263.	10209117.	10993993.	31063134.	17686854.	970896.
5	290716.	986674.	1328205.	555865.	751875.	825092.	2209393.	1360769.
6	10448.	18590.	56711.	54512.	30528.	53427.	38327.	132729.
BIOMASS	3910963.	4054953.	3826121.	6234874.	6360166.	4164032.	738373.	2787149.

TOTAL FISHING MORTALITY RATES

YEARS AGE	1972.	1973.	1974.	1975.	1976.	1977.	1978.	1979.
2	.003	.014	.011	.025	.005	.021	.030	.003
3	.014	.030	.040	.043	.053	.014	.179	.012
4	.034	.123	.125	.078	.060	.113	.035	.012
5	.220	.326	.663	.372	.114	.539	.282	.012
6	.220	.326	.663	.372	.114	.539	.282	.012

Table 11. Percent age-composition of mature capelin spawning inshore in NAFO Div. 3K and of mature capelin predicted from SCAM.

Inshore Div. 3K

Age	Year							
	1972	1973	1974	1975	1976	1977	1978	1979
3		2	31	40	61	2	27	16
4		90	46	53	38	92	33	41
5		8	20	5	1	5	38	27
6			3	2			1	15
				Predicted from SCAM				
3	22	12	17	20	35	13	<1	4
4	73	76	62	71	55	80	79	17
5	4	12	20	8	10	7	20	73
6	<1	<1	1	1	<1	<1	<1	7

Table 12. Details of data used to calculate 1979 capelin biomass in NAFO Div. 2J3K from the acoustic survey and relative biomass estimates for capelin from 1977-79.

Survey	Area		
	2J	3K (a)	3K (b)
Area (km^2)	1.922×10^4	3.810×10^4	6.869×10^3
Density/m^2	4.587×10^{-2}	8.150×10^{-4}	6.007×10^{-1}
$\bar{W}$ gms	7.1	9.5	9.5
% capelin by wt.	7.2	0.08	35.2
1979 capelin biomass	6260	39500	
1978 capelin biomass	0	7950-61800	
1977 capelin biomass	32,100-40,450	130,500-164,300	

Table 13. Total numbers-at-age ($x10^{-3}$), total biomass (metric tons), mature numbers-at-age ($x10^{-3}$), mature biomass (metric tons) for NAFO Div. 2J3K capelin, Jan. 1 of each year, 1972-79, F_T = 0.010.

TOTAL POPULATION AT START OF YEAR

YEARS / AGE	1972.	1973.	1974.	1975.	1976.	1977.	1978.	1979.
2	102214476.	123850142.	122095487.	322017640.	250772191.	11327712.	12757732.	190331824.
3	124871023.	75504608.	90508168.	89485096.	233276821.	185024670.	8242524.	9215917.
4	62664321.	81602344.	48171921.	57657889.	54966795.	146305418.	123217485.	4893196.
5	3302231.	11207811.	15089902.	6323414.	8577695.	9594577.	28477521.	18529988.
6	118676.	211164.	644198.	619431.	347512.	609832.	453031.	1776881.
BIOMASS	4262540.	4587518.	4622406.	6474965.	8109242.	6429828.	4377185.	2417895.

MATURE POPULATION AT START OF YEAR

YEARS / AGE	1972.	1973.	1974.	1975.	1976.	1977.	1978.	1979.
2	.	.	.	.	.	.	.	.
3	17481941.	11325692.	12671142.	16107318.	34991524.	22202961.	741827.	4147163.
4	57651172.	71810063.	47208483.	55351575.	50569449.	127285715.	119520964.	4257081.
5	3302231.	11207811.	15089902.	6323414.	8577695.	9594577.	28477521.	18529988.
6	118676.	211164.	644198.	619431.	347512.	609832.	453031.	1776881.
BIOMASS	1679368.	2181915.	1980877.	1916161.	2345908.	3766408.	4013406.	655870.

Table 14. Numbers-at-age ($x10^{-3}$) and biomass (metric tons) on Sept. 1 and total fishing mortality rates for NAFO Div. 2J3K capelin, 1972-79, F_T = 0.010.

TOTAL POPULATION-START OF FISHING (SEPT 1)

YEARS / AGE	1972.	1973.	1974.	1975.	1976.	1977.	1978.	1979.
2	83686135.	101399920.	99963330.	263645745.	205314904.	9274347.	10445147.	155830518.
3	91487759.	54854851.	66311537.	63361338.	169477937.	137834892.	6292329.	4995658.
4	12813885.	18865718.	7920666.	10250312.	11239860.	34801298.	21082703.	1163932.
5	290718.	986700.	1328467.	556693.	755153.	844676.	2507071.	1631321.
6	10448.	18590.	56713.	54533.	30594.	53688.	39883.	156431.
BIOMASS	3913140.	4064580.	3872761.	6731483.	7215323.	4878784.	873813.	3343539.

TOTAL FISHING MORTALITY RATES

YEARS / AGE	1972.	1973.	1974.	1975.	1976.	1977.	1978.	1979.
2	.003	.014	.011	.022	.004	018	.025	.002
3	.014	.030	.040	.042	.047	.012	.151	.010
4	.034	.123	.125	.078	.058	.101	.029	.010
5	.220	.326	.663	.371	.114	.523	.244	.010
6	.220	.326	.663	.371	.114	.523	.244	.010

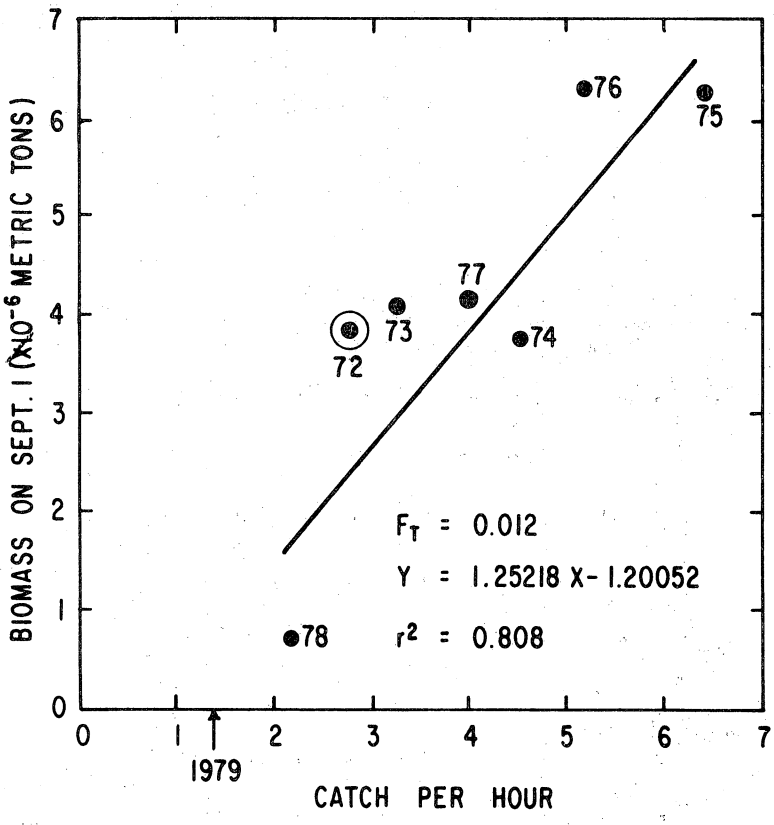

Fig. 1. Relationship between Div. 2J3K capelin biomass on Sept. 1 and catch per hour (USSR BMRT-A trawlers) when F_T = 0.012.

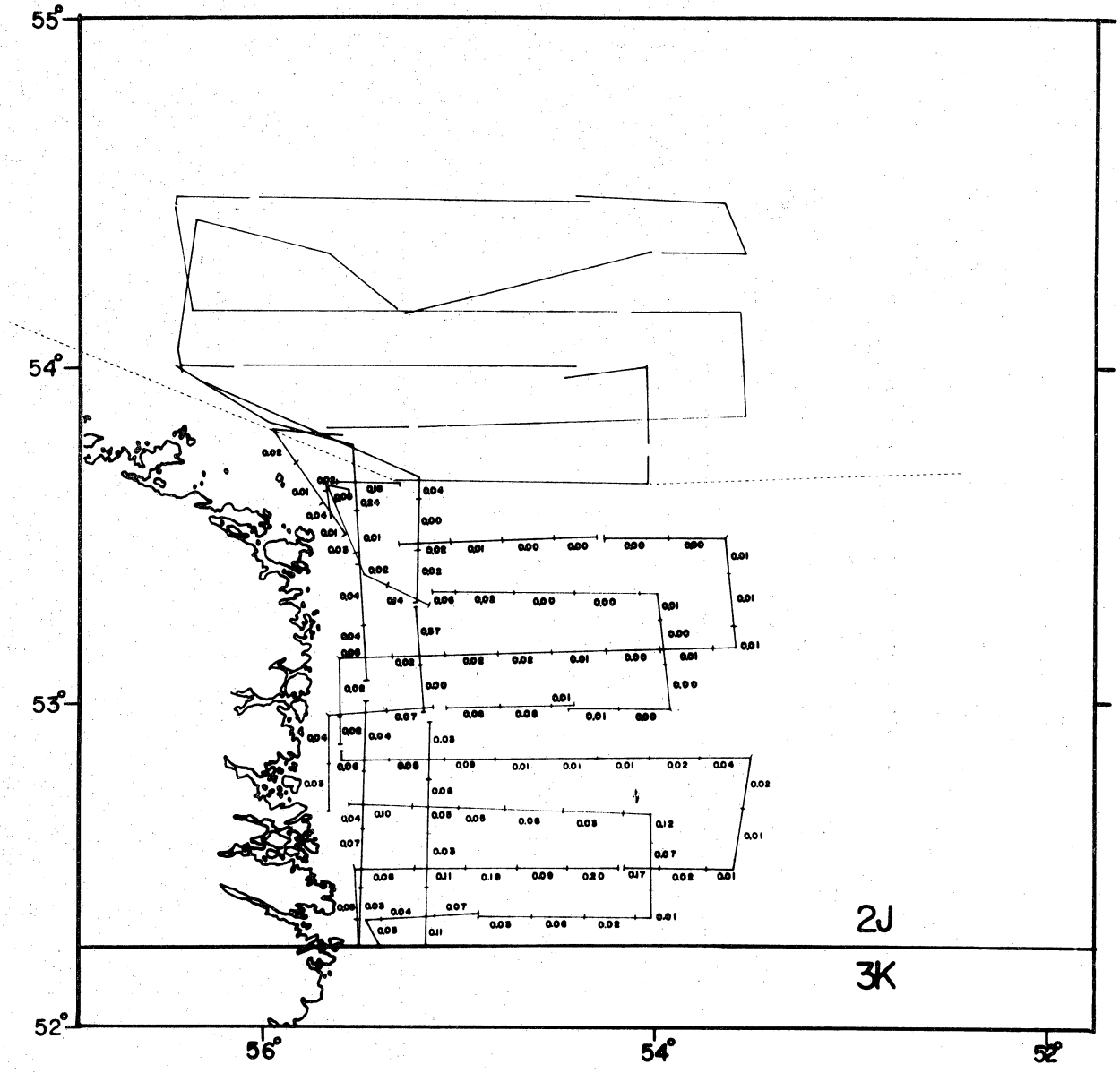

Fig. 2. Survey track and capelin density estimates. Div. 2J, 1979.

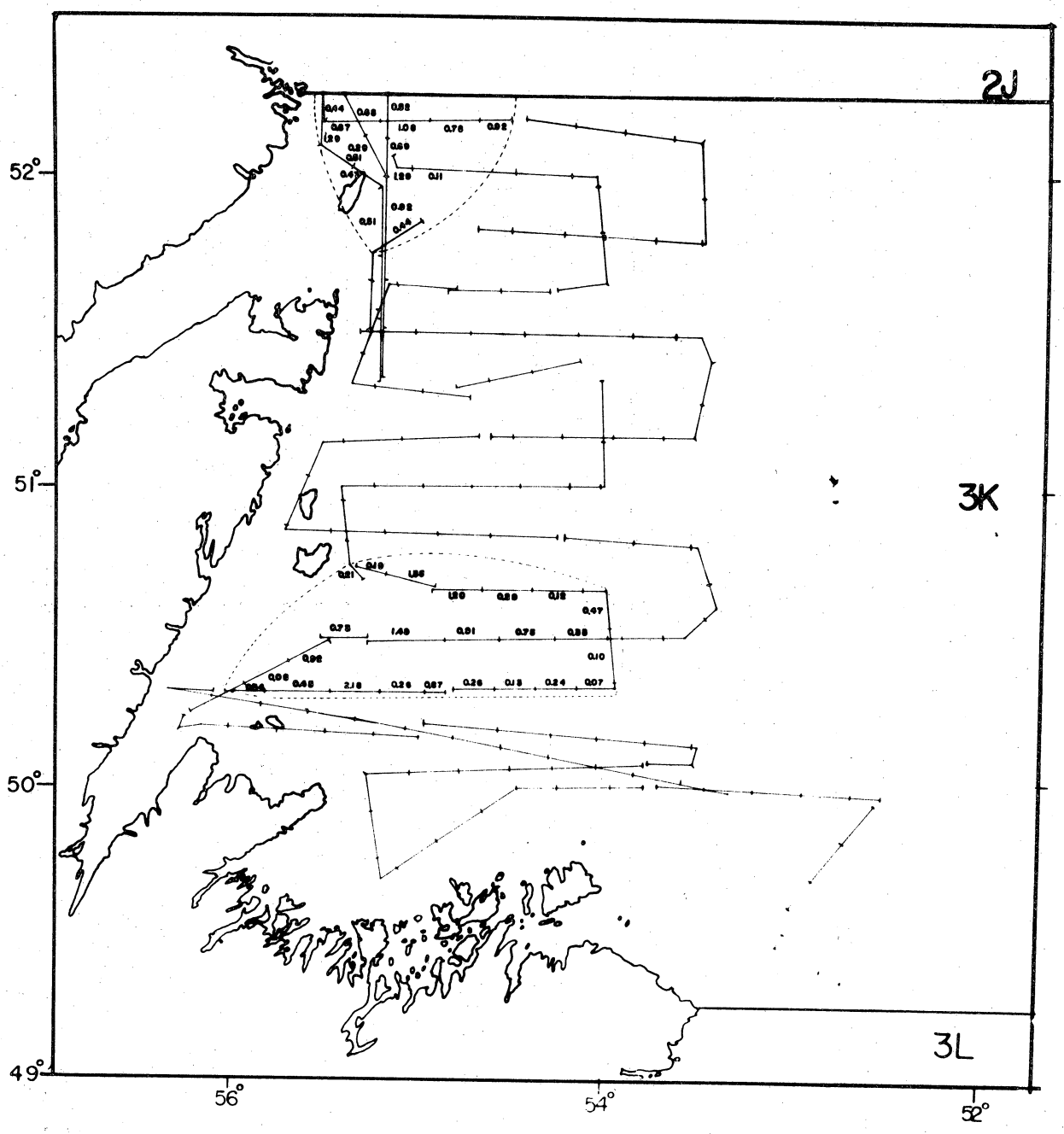

Fig. 3. Survey track and capelin density estimates. Div. 3K, 1979.

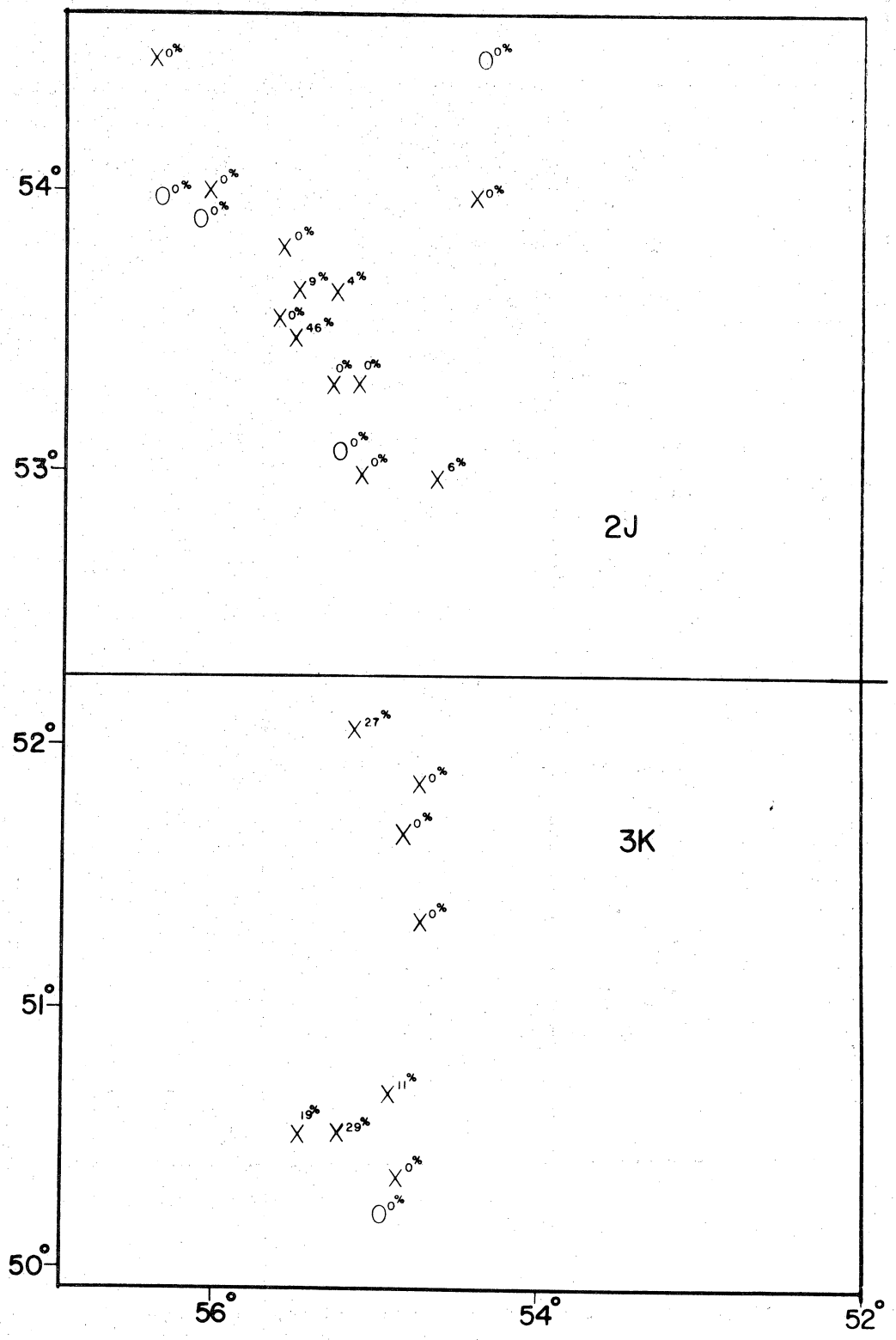

Fig. 4. Location of fishing sets and % capelin by weight, 2J3K, 1979.

O - bottom trawl sets
X - midwater trawl sets

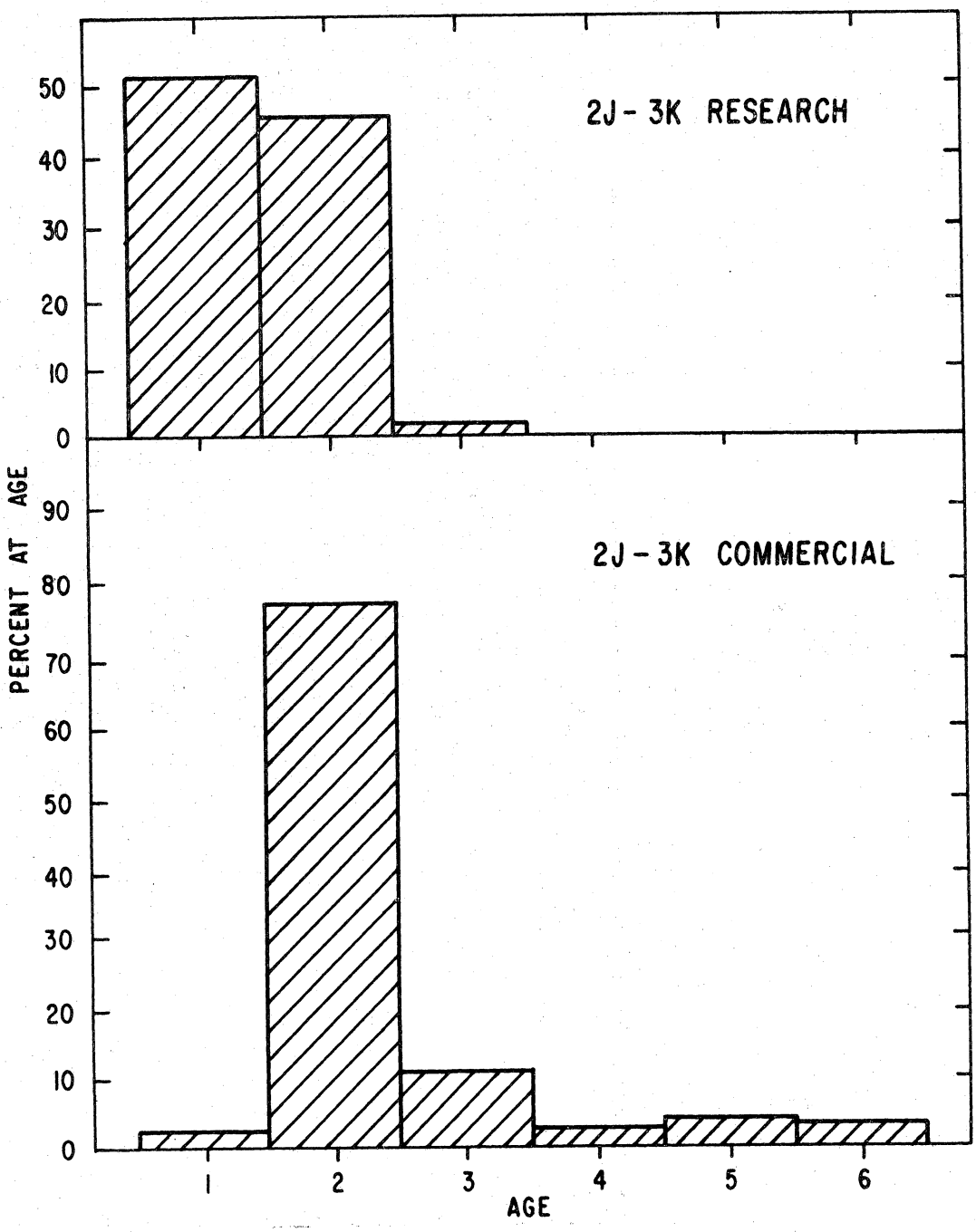

Fig. 5. Age composition of capelin from Div. 2J3K, 1979.

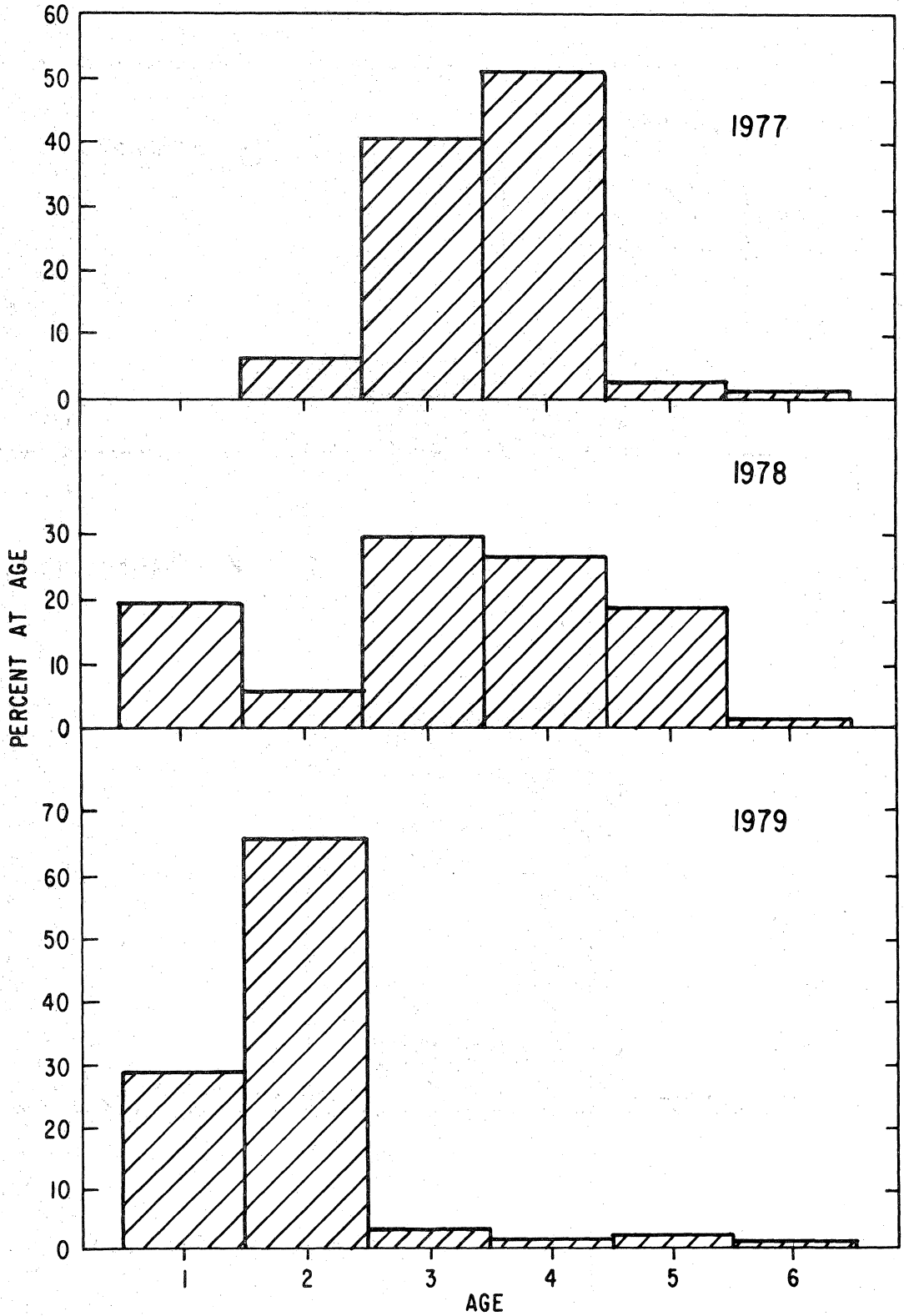

Fig. 6. Age-composition by weight of the biomass estimates of Div. 2J3K capelin, 1977-79.

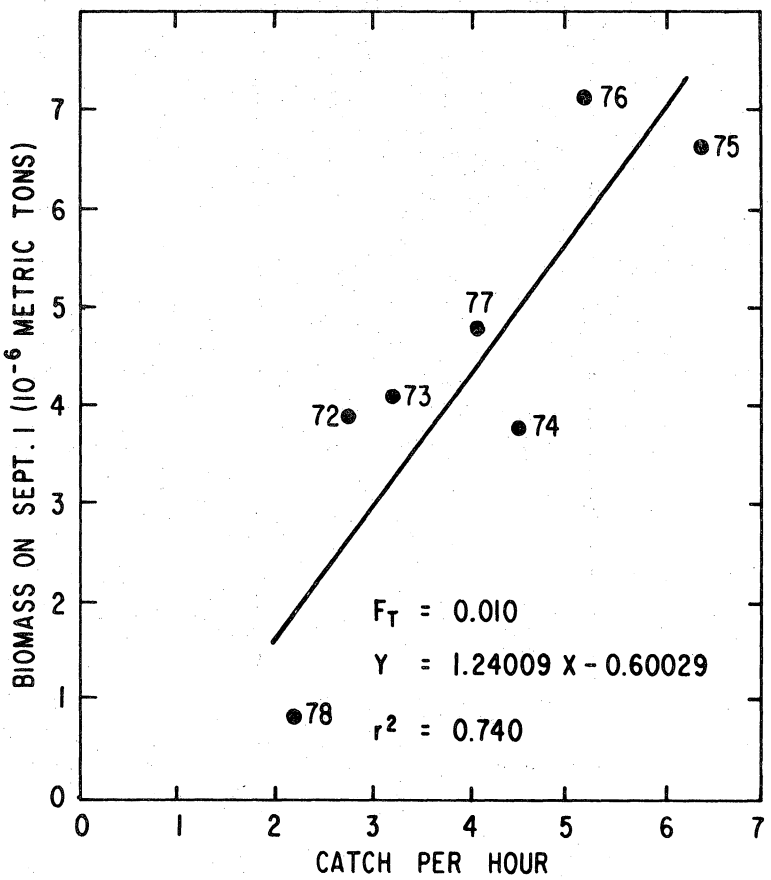

Fig. 7. Relationship between biomass on Sept. 1 and catch per hour when F_T = 0.010.