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Assessment of the Division 3L Capelin Stock, 1967-1980, using SCAM

by

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INTRODUCTION

Although small offshore catches of (<1500 t) of capelin were taken in NAFO Div. 3L in 1972 and 1973, the first substantial catches were reported in 1974 when 57,700 t were caught. Catches declined to about 34,000 t in 1975 and 1976, 27,000 t in 1977 and 25,000 t in 1978. No offshore fishing was allowed in 1979 and 1980 but the capelin fishery inshore in Newfoundland increased in these years and catches of 12,300 t in 1979 and 14,300 t (preliminary) in 1980 were reported.

In 1979, a sequential capelin abundance model for Div. 3L, SCAM 3L, was developed (Carscadden and Miller 1979). This model used information from the offshore commercial fishery, including catch and effort data to provide estimates of biomass and relative year-class strengths. However, the disappearance of this offshore fishery severely limited the use of this model. This paper presents the results of the use of this model incorporating information from the inshore fishery and information from SCAM 2J3K (Miller and Carscadden 1979).

NUMBERS-AT-AGE AND MEAN WEIGHT-AT-AGE

Data from the Soviet fishery in Div. 3L (Bakanev, pers. comm.) were used as a basis for numbers-at-age in the catch including the inshore catch in Div. 3L. The age-composition in the Soviet catch in Div. 3NO was used to provide numbers-at-age for 1971. Numbers-at-age for 1967-1970 were estimated using inshore catches in Div. 3L and age-composition and mean weight-at-age data from Winters and Campbell (1974). Numbers-at-age for the inshore catch in 1979 and 1980 were derived from Canadian sampling data.

Initially only data from 1972-1978 were used in order to use CPUE data (see below) from the offshore fishery to estimate terminal fishing mortality (Ft). From these initial runs of the model, it was obvious that 1973 and 1975 biomass estimates did not fit the pattern of CPUE. The 1973 point was eventually excluded because the catch was very low and it was early in the history of the fishery. In 1975, Canadian authorities closed eastern Canadian seaports to some fishing vessels alleging that, based on surveillance reports, the capelin quota was being exceeded by about 2 times by portions of the capelin fleet. Thus, the catch numbers were doubled for 1975 only and the analysis continued. The resulting numbers-at-age are given in Table 1. Mean weights-at-age derived from the same sources as numbers-at-age are given in Table 2. Both sets of data were used throughout the analysis.

CATCH PER UNIT EFFORT

Estimates of catch per hour were derived from ICNAF Statistical Bulletins for USSR trawlers >2000 GRT fishing in 3L in April and May, 1973-1978 (Table 3). The estimates of catch per hour do not show large fluctuations over the time series, ranging from 2.27 tons/hour in 1973 to 3.88 tons/hour in 1976.

PROPORTIONS MATURE-AT-AGE (p)

Estimates of proportions mature-at-age (Table 4) were derived from numbers-at-age and CPUE data using the method of Winters et al. (1980). In years with missing data, an average was used.

SELECTION FACTORS AND FISHING MORTALITY

The SCAM was first run using only 1972-1978 data with selection factors set at 1.0. From these initial runs, selection factors were calculated by expressing the mean estimates of F at age each year as a fraction of the highest mean F for that year. The model was then rerun with these selection factors. The biomasses calculated did not show a good relationship with catch per hour and an examination of the data suggested that the catch-at-age data may have been poor in some years, especially for older ages. Consequently, ages 5 and 6 were combined, mean weight-at-age was weighted by number of fish at ages 5 and 6, and proportions mature for age 5 were set at 1.0 for all future runs of SCAM. The model was also rerun such that fishing was considered to be incomplete on the final age in the fishery each year.

With these changes, the model was run over a range of F's from 0.05 to .50 with selection factors set at 1.0 for all ages. An examination of the matrix of F's in early years of the series suggested that the selection factors should be 1.0 for all ages and these runs were used in the estimation of terminal fishing mortality (Ft). The best fit between total biomass on Jan 1 and catch per hour occurred at Ft = 0.10 (Fig. 1). Total biomass was used in this relationship because an examination of the original Soviet sampling data showed that one and two year-old capelin were taken most years in the fishery. Details of the SCAM run at Ft = 0.10 are given in Table 5.

The results from this run were then used as a guide in running the 14 year time series of data from 1967-1980. A series of runs of SCAM were made with selection factors set at 1.0 and a series of F's ranging from 0.01 to 0.20. The relationship between total biomass on Jan. 1 and catch per hour for the years 1974-1978 was examined. The best fit occurred at Ft = 0.02 in 1980 (Fig 2) although the relationship was not statistically significant (r = .81). However, the biomass estimates in the two series were close except for 1978. The major difference in this year was the estimate of the 1975 year-class which is a function of Ft in 1980. Thus the run of SCAM with Ft = 0.02 in 1980 was accepted and details of this run are given in Table 6.

REFINEMENTS OF THE ESTIMATES

In an attempt to refine the estimates in the early and later years of the series, comparisons of estimates of year-class strength of capelin at age 2+ in Div. 2J3K (Method 2 Carscadden and Miller 1981) and at age 3 in this series were made (Fig. 3). There was a good correlation (r = .95) in estimates of year-class strength between the two areas for year-classes 1970-1974. Although the 1969 year-class was estimated to be weaker than the 1973 year-class in the Div. 2J3K stock, it was estimated to be stronger than the 1973 year-class in Div. 3L stock. Another discrepancy in estimates of year-class strengths occurred in the estimation of the size of the 1968 year-class. In the Div. 2J3K stock, the 1968 year-class was relatively weak (i.e. about 1/5 of the strong 1973 year-class) whereas in the south, the 1968 year-class was estimated to be very strong. These differences may be real or may have resulted from the use of average values of p for early years in the SCAM's. To illustrate the effect of changing the values of p, two additional runs were made, both aimed at fixing the size of the 1969 year-class close to that predicted from Fig. 3 (about 12×10^9 individuals). In the first instance, the value of p for the 1969 year-class at age 4 was reduced from 0.87 to 0.40 and this reduced the size of the 1969 year-class at age 3 from 29.5×10^9 individuals to 12.7×10^9 individuals (Table 7). The effect of this change in p also affects earlier years in the series because of the new estimate of F and the way in which the model operates. In the second change, the p at age 3 of the 1969 year-class was reduced from 0.47 to 0.05. In this case, although the value of p was drastically reduced, the 1969 year-class was reduced by about one-third from 29.5×10^9 individuals to 19.8×10^9 individuals (Table 8).

To provide estimates of relative year-class strengths in Div. 3L samples, the catch data were converted to per mille compositions. Then, these values were summed by year-class to provide them relative estimates (Table 9). These results suggest that in the 14-year time series, the 1973 year-class was strongest, followed by the 1964, 1968 and 1969 year-classes.

These indices of relative year-class strength were then plotted against estimates of year-class strength in the mature population from the original SCAM run (Table 6) and the two illustrative runs (Tables 7 and 8) where the values of p were changed. The relationship between estimated year-class strength of mature fish from SCAM (p unchanged) and the indices of relative abundance is statistically significant and curvilinear (Fig 4). The estimate of the 1973 year-class from SCAM would appear to be too low in relation to the 1964, 1968 and 1969 year-classes. The relationship between the SCAM estimates

with p for the 1969 year-class changed at age 4 and the indices of relative year-class strength is statistically significant and linear (Fig. 5). In this case, the 1973 year-class appears to better fit the pattern of relative year-class strengths provided from the catch data. The change in p in the SCAM run did not change the estimated strength of the 1973 year-class but did lower the estimates for the year-classes prior to 1969.

The relationship between the estimates of year-class strength from SCAM when the p for the 1969 year-class at age 3 was changed and the indices of abundance from the catch data is not statistically significant (Fig. 6).

In summary, although the change in p at age 4 for the 1969 year-class was arbitrary, the results of such a change fit well with the pattern of relative year-class strengths found by the catch data and in the estimates from SCAM 2J3K (Carscadden and Miller 1981).

Estimates of the 1975-1978 year-classes at age 3 (Table 10) were made using the regression in Fig. 3. These results show slight improvement in recruitment in the 1977 and 1978 year-classes after relatively poor recruitment in the 1975 and 1976 year-classes. The predicted size of the 1978 year-class in 9.9×10^9 individuals. This year-class accounts for a sizeable proportion of the biomass in 1981.

DISCUSSION

Although the trends in biomass for Div. 3L capelin agree reasonably well with trends in catch per unit effort for the years 1974-1978, there is still some doubt about the relative sizes of the dominant year-classes in the entire series - the 1964, 1968, 1969 and 1973 year-classes. These are important from a historical perspective but since they have disappeared from the population are relatively unimportant for the purposes of projection. In this respect, the sizes of the 1976, 1977 and especially the 1978 year-classes are of critical importance. The estimate for the size of the 1978 year-class is highly dependent on the estimates of this year-class from the Div. 2J3K stock (Carscadden and Miller 1981). These authors have discussed possible sources of error in the estimation of the strength of this year-class.

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Table 1. Number-at-age ($x10^{-3}$) in capelin catch from NAFO Div. 3L, 1967-1980.

Year	Age 3	4	5	6
1967	32,290	17,013	5,729	347
1968	18,445	21,232	2,521	398
1969	1,424	17,402	31,798	3,797
1970	40,561	18,581	8,158	1,813
1971	20,436	10,336	800	4
1972	21,213	26,704	2,485	0
1973	23,137	100,386	34,063	315
1974	1,044,986	756,598	584,872	36,505
1975	1,117,126	822,411	117,582	76,606
1976	1,156,032	278,413	50,663	3,056
1977	346,096	814,271	37,064	0
1978	70,315	412,760	409,020	14,715
1979	253,267	164,842	64,920	7,987
1980	328,236	208,811	8,940	1,831

Table 2. Mean weights-at-age (g) of capelin from Div. 3L, 1967-1980.

Year	Age 3	4	5	6
1967	29.4	33.7	32.2	43.0
1968	27.6	34.1	34.9	31.0
1969	24.2	31.4	31.2	33.6
1970	29.0	34.8	35.4	33.6
1971	23.8	31.9	37.4	25.9
1972	21.5	26.7	28.7	-
1973	17.4	21.3	28.7	35.4
1974	19.7	26.4	26.9	25.8
1975	20.2	31.5	33.2	33.0
1976	19.3	26.8	27.2	33.8
1977	15.3	24.4	31.5	-
1978	16.4	24.5	30.6	35.8
1979	15.7	23.8	28.1	27.2
1980	15.3	19.1	25.7	30.3

Table 3. Estimates of catch per hour of Soviet trawlers, > 2000 GRT fishing in Div. 3L, April and May, 1973-1978.

Catch/hour					
1973	1974	1975	1976	1977	1978
2.27	3.42	3.40	3.88	3.68	3.31

Table 4. Values of p, proportion mature at age, for capelin used in SCAM 3L.

	Age			
Year	3	4	5	6
1967	.47	.87	.93	1.0
1968	.47	.87	.93	1.0
1969	.47	.87	.93	1.0
1970	.47	.87	.93	1.0
1971	.47	.87	.93	1.0
1972	.47	.87	.93	1.0
1973	.39	.87	1.0	1.0
1974	.62	1.0	.97	1.0
1975	.61	1.0	1.0	1.0
1976	.35	.85	1.0	1.0
1977	.36	.62	.68	1.0
1978	.47	.87	.93	1.0
1979	.47	.87	.93	1.0
1980	.47	.87	.93	1.0

Table 5. Details of SCAM run using only 1972-1978 data with selection factors set at 1.0 for each age and F_T = 0.10.

TOTAL POPULATION AT START OF YEAR

YEARS	1972	1973	1974	1975	1976	1977	1978
3	29603410.	9078927.	8248201.	5086426.	24644323.	9934166.	1666400.
4	19577725.	14177526.	4746941.	3063265.	1824804.	13236920.	5298108.
5	1583363.	4221422.	3038385.	539053.	299542.	373532.	4731913.

TOTAL BIOMASS-BEGINNING OF YEAR

1972	1973	1974	1975	1976	1977	1978
1204641.	581532.	369237.	217081.	532808.	486740.	302876.

MATURE POPULATION START OF YEAR

YEARS	1972	1973	1974	1975	1976	1977	1978
3	13929668.	3549082.	5109754.	3101065.	8616751.	3583458.	783208.
4	17013479.	12331900.	4746941.	3063265.	1552528.	8203637.	4609354.
5	1583363.	4221422.	3038385.	539053.	299542.	373532.	4731913.

MATURE BIOMASS-BEGINNING OF YEAR

1972	1973	1974	1975	1976	1977	1978
799190.	446000.	307410.	176977.	216178.	266762.	271517.

MATURE POPULATION BEFORE SPAWNING

YEARS	1972	1973	1974	1975	1976	1977	1978
3	12272976.	3110321.	3530795.	1693124.	6520713.	2837982.	625404.
4	14989276.	10788590.	3480090.	1933826.	1109288.	6476373.	3680644.
5	1394980.	3693120.	2099497.	294313.	214024.	294885.	3778510.

MATURE BIOMASS-BEFORE SPAWNING

1972	1973	1974	1975	1976	1977	1978
704119.	390278.	217698.	104858.	161486.	210734.	216810.

TOTAL POPULATION BEFORE SPAWNING

YEARS	1972	1973	1974	1975	1976	1977	1978
3	26105005.	7990392.	6300464.	3445199.	20664995.	8442462.	1404819.
4	17252214.	12417350.	3480090.	1933826.	1349571.	10918230.	4288467.
5	1394980.	3693120.	2099497.	294313.	214024.	294885.	3778510.

TOTAL BIOMASS-BEFORE SPAWNING

1972	1973	1974	1975	1976	1977	1978
1061928.	509884.	272260.	140250.	440910.	404863.	244485.

FISHING MORTALITY ON MATURES

YEARS	1972	1973	1974	1975	1976	1977	1978
3	.002	.007	.245	.480	.154	.108	.100
4	.002	.009	.185	.335	.211	.111	.100
5	.002	.009	.245	.480	.211	.111	.100

WEIGHTED F ON MATURES

1972	1973	1974	1975	1976	1977	1978
.002	.008	.223	.414	.164	.110	.100

Table 6. Details of SCAM run in which values of p, proportions mature at age are unchanged. Numbers $\times 10^{-3}$ and biomass (tons).

TOTAL POPULATION AT START OF YEAR

AGE	3	4	5	Biomass
1967	86190804.	3610466.	1120201.	2689736.
1968	10457466.	41293114.	775722.	1723406.
1969	4822654.	5012419.	8900368.	556966.
1970	15281057.	2310678.	1078364.	561413.
1971	40724901.	7317492.	494692.	1221132.
1972	29498065.	19508237.	1577743.	1200359.
1973	9024064.	14127036.	4206417.	579069.
1974	8215489.	4718189.	3027483.	367542.
1975	5053122.	3049235.	535125.	215837.
1976	24451589.	1812710.	297626.	528711.
1977	9857303.	13127979.	370579.	482813.
1978	5855152.	5255535.	4690241.	369244.
1979	27031929.	2792298.	1073331.	520911.
1980	37511488.	12891697.	578538.	835488.

TOTAL POPULATION BEFORE SPAWNING

AGE	3	4	5	Biomass
1967	76032798.	3170241.	982871.	2372081.
1968	9211340.	36421108.	681832.	1519648.
1969	4254640.	4407085.	7821132.	489914.
1970	13447379.	2021719.	942293.	493404.
1971	35920417.	6447961.	435809.	1076851.
1972	26012039.	17190892.	1390021.	1058149.
1973	7941995.	12372793.	3679879.	507712.
1974	6271607.	3454735.	2089882.	270764.
1975	3415857.	1921451.	290855.	139153.
1976	20494920.	1338903.	212334.	437295.
1977	8374623.	10822075.	292280.	401397.
1978	5101331.	4250899.	3741737.	303054.
1979	23617891.	2309560.	878819.	450375.
1980	32795688.	11180891.	500448.	728591.

MATURE POPULATION START OF YEAR

1967	40539846.	3139264.	1120201.	1331719.
1968	4909299.	35898720.	775722.	1386328.
1969	2268120.	4357381.	8900368.	474250.
1970	7181441.	2010184.	1078364.	316067.
1971	19157873.	6359113.	494692.	677265.
1972	13880141.	16953106.	1577743.	796352.
1973	3527713.	12288033.	4206417.	444262.
1974	5091418.	4718189.	3027483.	305998.
1975	3078471.	3049235.	535125.	175949.
1976	8555925.	1542587.	297626.	214685.
1977	3557627.	8139023.	370579.	264697.
1978	2753094.	4568782.	4690241.	301545.
1979	12710107.	2426816.	1073331.	287360.
1980	17630401.	11215776.	578538.	499298.

FISHING MORTALITY ON MATURES

1967	.001	.006	.006
1968	.004	.001	.004
1969	.001	.004	.004
1970	.006	.010	.010
1971	.001	.002	.002
1972	.002	.002	.002
1973	.007	.009	.009
1974	.246	.187	.246
1975	.485	.337	.485
1976	.155	.213	.213
1977	.109	.112	.112
1978	.027	.101	.101
1979	.021	.075	.075
1980	.020	.020	.020

MATURE POPULATION BEFORE SPAWNING

1967	35745970.	2754407.	982871.	1173634.
1968	4315099.	31660572.	681832.	1222177.
1969	2000271.	3829016.	7821132.	416918.
1970	6299493.	1756534.	942293.	276887.
1971	16887582.	5602195.	435809.	596890.
1972	12229269.	14935997.	1390021.	701614.
1973	3091482.	10749878.	3679879.	388745.
1974	3514623.	3454735.	2089882.	216452.
1975	1673234.	1921451.	290855.	103952.
1976	6467046.	1100520.	212334.	160168.
1977	2815178.	6419337.	292280.	208911.
1978	2363774.	3644841.	3741737.	243310.
1979	10978927.	1987023.	878819.	244267.
1980	15250690.	9701897.	500448.	431904.

Table 7. Details of SCAM run in which p, proportion mature at age, was changed at age 4 for 1969 year-class. Numbers $\times 10^{-3}$ and biomass in tons.

TOTAL POPULATION AT START OF YEAR

AGE	3	4	5	Biomass
1967	17842625.	758951.	235612.	557312.
1968	2167854.	8551817.	161225.	356996.
1969	986724.	1035669.	1841765.	114932.
1970	3072810.	473113.	220780.	113325.
1971	8110577.	1466365.	99173.	243508.
1972	12704065.	3884391.	314267.	385870.
1973	9024064.	6089857.	832647.	310713.
1974	8215489.	4718189.	3027483.	367542.
1975	5053122.	3049235.	535125.	215837.
1976	24451589.	1812710.	297626.	528711.
1977	9857303.	13127979.	370579.	482813.
1978	5855152.	5255535.	4690241.	369244.
1979	27031929.	2792298.	1073331.	520911.
1980	37511488.	12891697.	578538.	835488.

MATURE POPULATION START OF YEAR

1967	8376753.	659712.	235612.	275671.
1968	1018692.	7433062.	161225.	287129.
1969	463043.	900367.	1841765.	97943.
1970	1441796.	411533.	220780.	63883.
1971	3811006.	1275468.	99173.	135088.
1972	5963299.	3378610.	314267.	227439.
1973	3527713.	2432284.	832647.	137170.
1974	5091418.	4718189.	3027483.	305998.
1975	3078471.	3049235.	535125.	175949.
1976	8555925.	1542587.	297626.	214685.
1977	3557627.	8139023.	370579.	264697.
1978	2753094.	4568782.	4690241.	301545.
1979	12710107.	2426816.	1073331.	287360.
1980	17630401.	11215776.	578538.	499298.

MATURE POPULATION BEFORE SPAWNING

1967	7362101.	566227.	202224.	241675.
1968	881682.	6539675.	139541.	252138.
1969	407294.	778238.	1591943.	84828.
1970	1234314.	345737.	185482.	54337.
1971	3344000.	1115890.	86765.	118420.
1972	5242645.	2956535.	275007.	199549.
1973	3091482.	2052249.	702550.	117738.
1974	3514623.	3454735.	2089882.	216452.
1975	1673234.	1921451.	290855.	103952.
1976	6467046.	1100520.	212334.	160168.
1977	2815178.	6419337.	292280.	208911.
1978	2363774.	3644841.	3741737.	243310.
1979	10978927.	1987023.	878819.	244267.
1980	15250690.	9701897.	500448.	431904.

TOTAL POPULATION BEFORE SPAWNING

AGE	3	4	5	
1967	15715704.	653805.	202224.	490223.
1968	1895813.	7526974.	139541.	313794.
1969	869441.	897642.	1591943.	99821.
1970	2673679.	400081.	185482.	97970.
1971	7138358.	1284356.	86765.	214100.
1972	11191351.	3402884.	275007.	339364.
1973	7941995.	5280047.	702550.	270889.
1974	6271607.	3454735.	2089882.	270764.
1975	3415857.	1921451.	290855.	139153.
1976	20494920.	1338903.	212334.	437295.
1977	8374623.	10822075.	292280.	401397.
1978	5101331.	4250899.	3741737.	303054.
1979	23617891.	2309560.	878819.	450375.
1980	32795688.	11180891.	500448.	728591.

FISHING MORTALITY ON MATURES

1967	.004	.028	.028
1968	.019	.003	.019
1969	.003	.021	.021
1970	.030	.049	.049
1971	.006	.009	.009
1972	.004	.008	.008
1973	.007	.045	.045
1974	.246	.187	.246
1975	.485	.337	.485
1976	.155	.213	.213
1977	.109	.112	.112
1978	.027	.101	.101
1979	.021	.075	.075
1980	.020	.020	.020

Table 8. Details of SCAM run in which value of p, proportion mature age age, for age 3, 1969 year-class was changed. Numbers $\times 10^{-3}$ and biomass in tons.

TOTAL POPULATION AT START OF YEAR

AGE	3	4	5	Biomass
1967	7010227.	303895.	94322.	219209.
1968	850304.	3356493.	63098.	140095.
1969	377921.	404444.	719912.	44725.
1970	1132994.	180756.	84426.	42110.
1971	40724901.	534877.	36168.	987664.
1972	19804961.	19508237.	113859.	949944.
1973	9024064.	14127036.	4206417.	579069.
1974	8215489.	4718189.	3027483.	367542.
1975	5053122.	3049235.	535125.	215837.
1976	24451589.	1812710.	297626.	528711.
1977	9857303.	13127979.	370579.	482813.
1978	5855152.	5255535.	4690241.	369244.
1979	27031929.	2792298.	1073331.	520911.
1980	37511488.	12891697.	578538.	835488.

TOTAL POPULATION BEFORE SPAWNING

AGE	3	4	5	
1967	6156185.	252225.	77539.	191849.
1968	733080.	2942154.	52945.	122382.
1969	332177.	340589.	601922.	37864.
1970	961814.	142098.	65158.	35125.
1971	35920417.	462326.	31163.	870816.
1972	17457908.	17190892.	98148.	837159.
1973	7941995.	12372793.	3679879.	507712.
1974	6271607.	3454735.	2089882.	270764.
1975	3415857.	1921451.	290855.	139153.
1976	20494920.	1338903.	212334.	437295.
1977	8374623.	10822075.	292280.	401397.
1978	5101331.	4250899.	3741737.	303054.
1979	23617891.	2309560.	878819.	450375.
1980	32795688.	11180891.	500448.	728591.

MATURE POPULATION START OF YEAR

1967	3290447.	264118.	94322.	108507.
1968	398810.	2919193.	63098.	112722.
1969	177844.	352021.	719912.	38211.
1970	533005.	157322.	84426.	23895.
1971	19157873.	464946.	36168.	472138.
1972	971919.	16953106.	113859.	476812.
1973	3527713.	12288033.	4206417.	444262.
1974	5091418.	4718189.	3027483.	305998.
1975	3078471.	3049235.	535125.	175949.
1976	8555925.	1542587.	297626.	214685.
1977	3557627.	8139023.	370579.	264697.
1978	2753094.	4568782.	4690241.	301545.
1979	12710107.	2426816.	1073331.	287360.
1980	17630401.	11215776.	578538.	499298.

FISHING MORTALITY ON MATURES

1967	.010	.071	.071
1968	.050	.008	.050
1969	.009	.054	.054
1970	.084	.134	.134
1971	.001	.024	.024
1972	.023	.002	.023
1973	.007	.009	.009
1974	.246	.187	.246
1975	.485	.337	.485
1976	.155	.213	.213
1977	.109	.112	.112
1978	.027	.101	.101
1979	.021	.075	.075
1980	.020	.020	.020

MATURE POPULATION BEFORE SPAWNING

1967	2873490.	217123.	77539.	94155.
1968	334638.	2556237.	52945.	98225.
1969	155610.	294326.	601922.	32115.
1970	432326.	121418.	65158.	19050.
1971	16887582.	400612.	31163.	415866.
1972	837806.	14935997.	98148.	419621.
1973	3091482.	10749878.	3679879.	388745.
1974	3514623.	3454735.	2089882.	216452.
1975	1673234.	1921451.	290855.	103952.
1976	6467046.	1100520.	212334.	160168.
1977	2815178.	6419337.	292280.	208911.
1978	2363774.	3644841.	3741737.	243310.
1979	10978927.	1987023.	878819.	244267.
1980	15250690.	9701897.	500448.	431904.

Table 9. Per mille age compositions of Div. 3L capelin from catch matrix and relative indicies of year-class strength.

Year	Age 3	4	5	Year-class	Relative index of year-class strength
1967	583	307	110	1964	1,735
1968	433	498	69	1965	897
1969	26	320	654	1966	320
1970	587	269	144	1967	963
1971	647	327	25	1968	1,395
1972	421	530	49	1969	1,313
1973	146	636	218	1970	549
1974	431	312	256	1971	852
1975	524	385	91	1972	742
1976	777	187	36	1973	1,924
1977	289	680	31	1974	892
1978	77	455	467	1975	433
1979	516	336	148		
1980	599	381	20		

Table 10. Total population and biomass estimates on January 1, 1978-1981 are based on predicted values and 1967-77 are from the SCAM run in Table 7.

Year	3	4	5	Biomass
1967	17,842,625	758,951	235,612	557,312
1968	2,167,854	8,551,817	161,225	356,996
1969	986,724	1,035,669	1,841,765	114,932
1970	3,072,810	473,113	220,780	113,325
1971	8,110,577	1,466,365	99,173	243,508
1972	12,704,065	3,884,391	314,267	385,870
1973	9,024,064	6,089,857	832,647	310,713
1974	8,215,489	4,718,189	3,027,483	367,542
1975	5,053,122	3,049,235	535,125	215,837
1976	24,451,589	1,812,710	297,626	528,711
1977	9,857,303	13,127,979	370,579	482,813
1978	5,120,000	5,255,535	4,690,241	357,188
1979	5,010,000	2,440,500	1,073,331	166,794
1980	6,020,000	2,351,836	501,285	150,310
1981	9,900,000	2,821,262	475,804	302,257

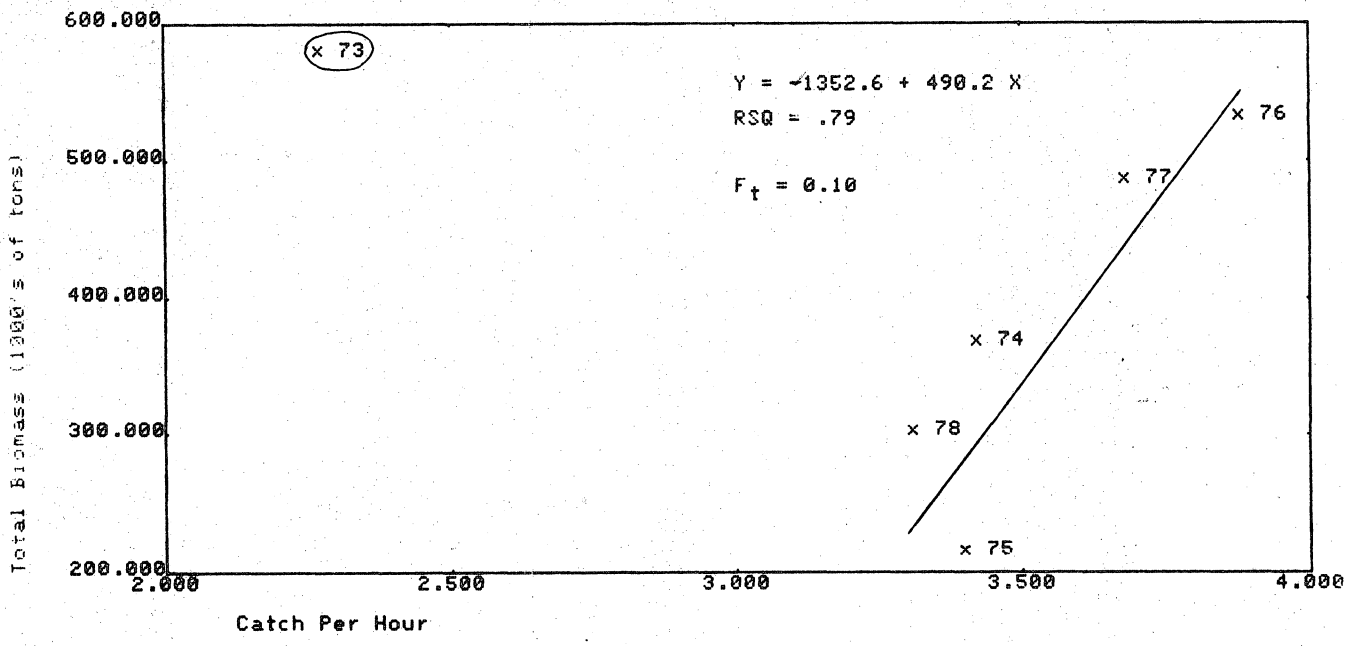

Fig. 1. Relationship between catch per hour and total biomass of capelin on January 1 using only 1972-1978 data.

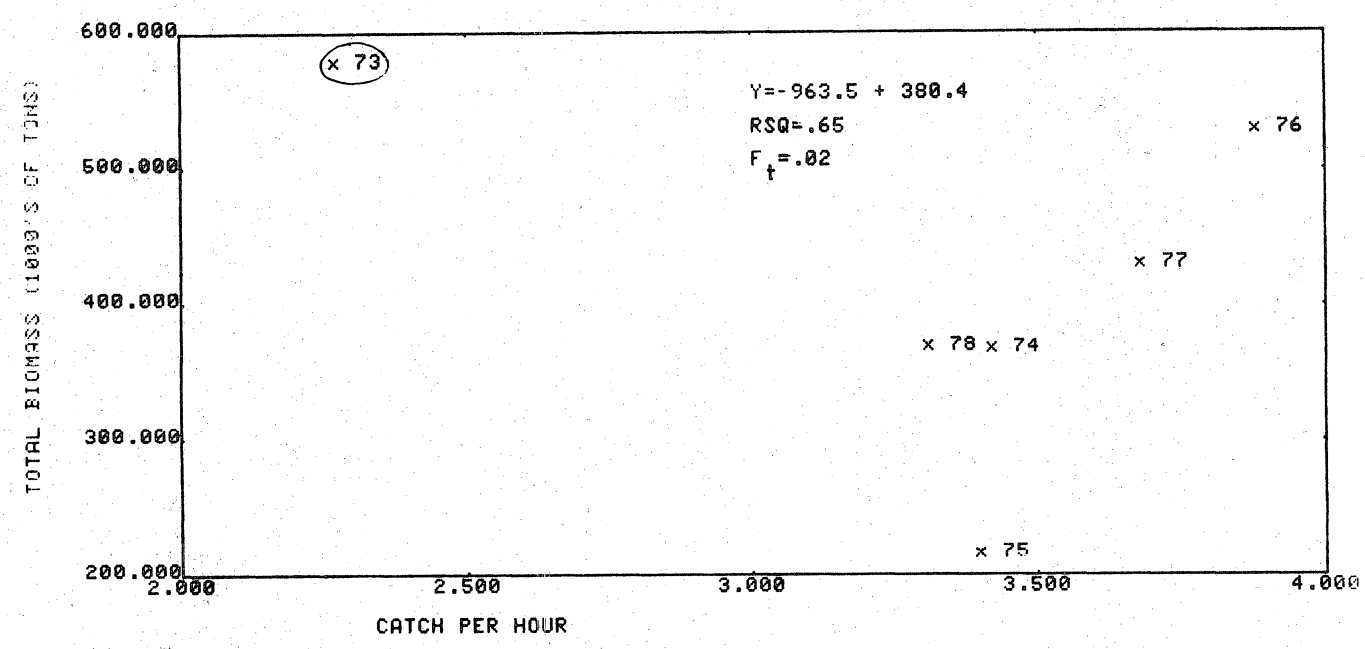

Fig. 2. Relationship between catch per hour and total biomass of capelin on January 1 using 1967-1980 data.

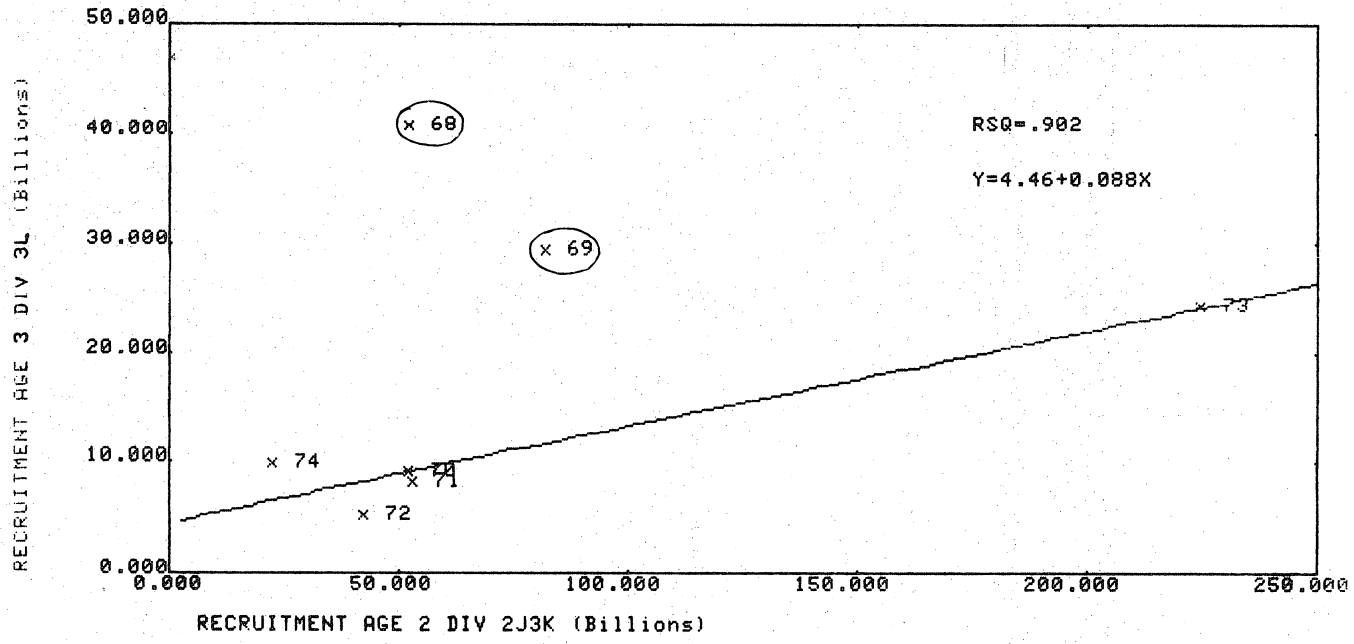

Fig. 3. Relationship between recruitment of age 2 in Div. 2J3K and recruitment at age 3 in Div. 3L capelin, 1970-1974 year-classes. The 1968 and 1969 year-classes were not included in the regression.

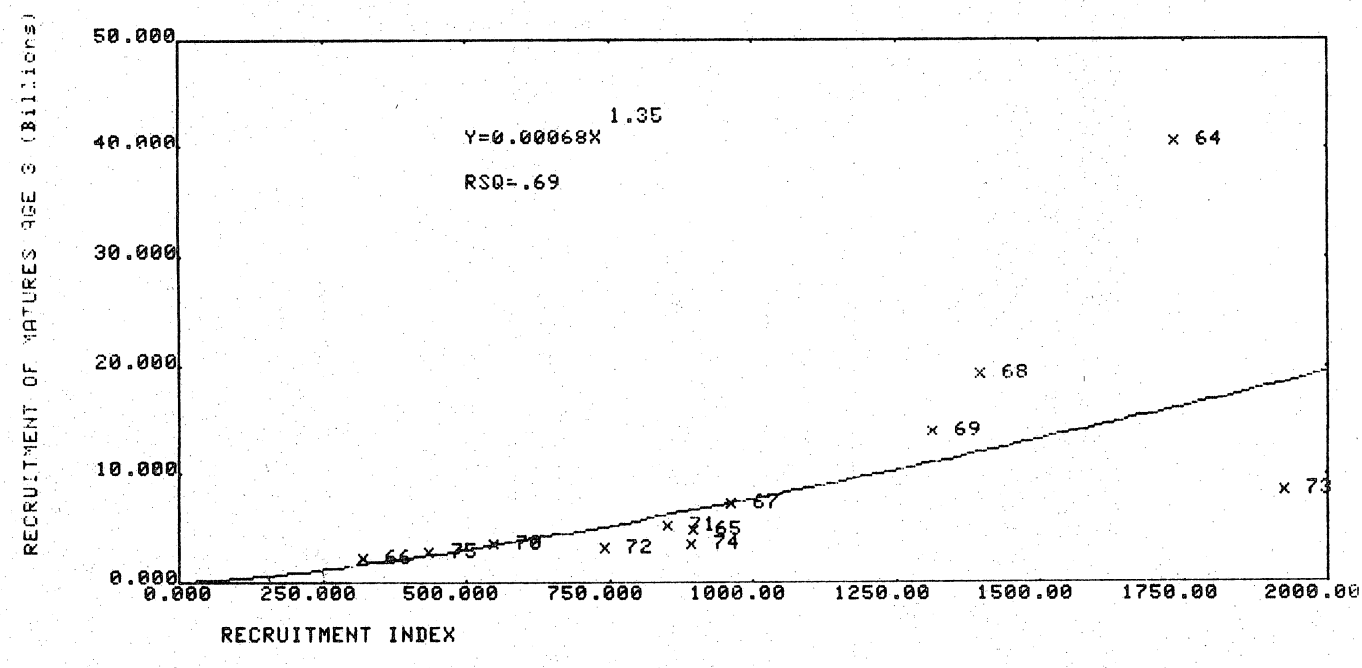

Fig. 4. Relationship between recruitment index from catch data and recruitment of mature capelin at age 3 with values of p, proportion mature at age unchanged.

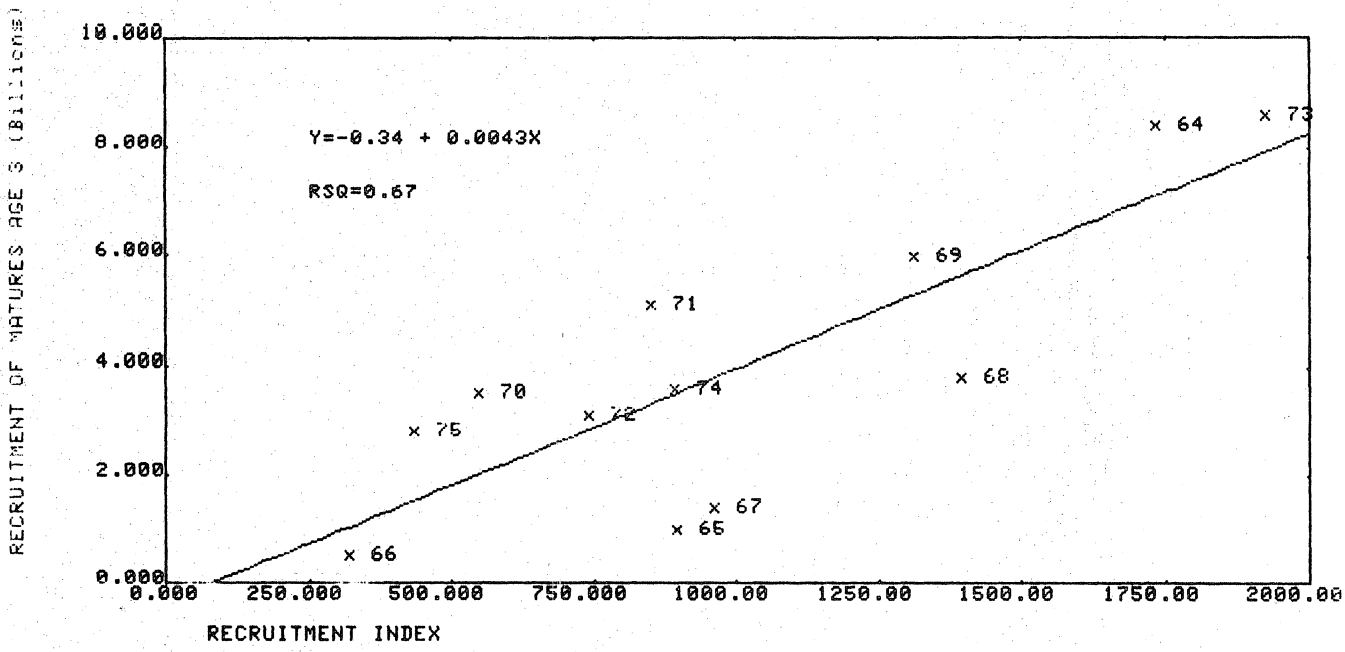

Fig. 5. Relationship between recruitment index from catch data and recruitment of mature capelin at age 3 with the value of p changed for the 1969 year-class at age 4.

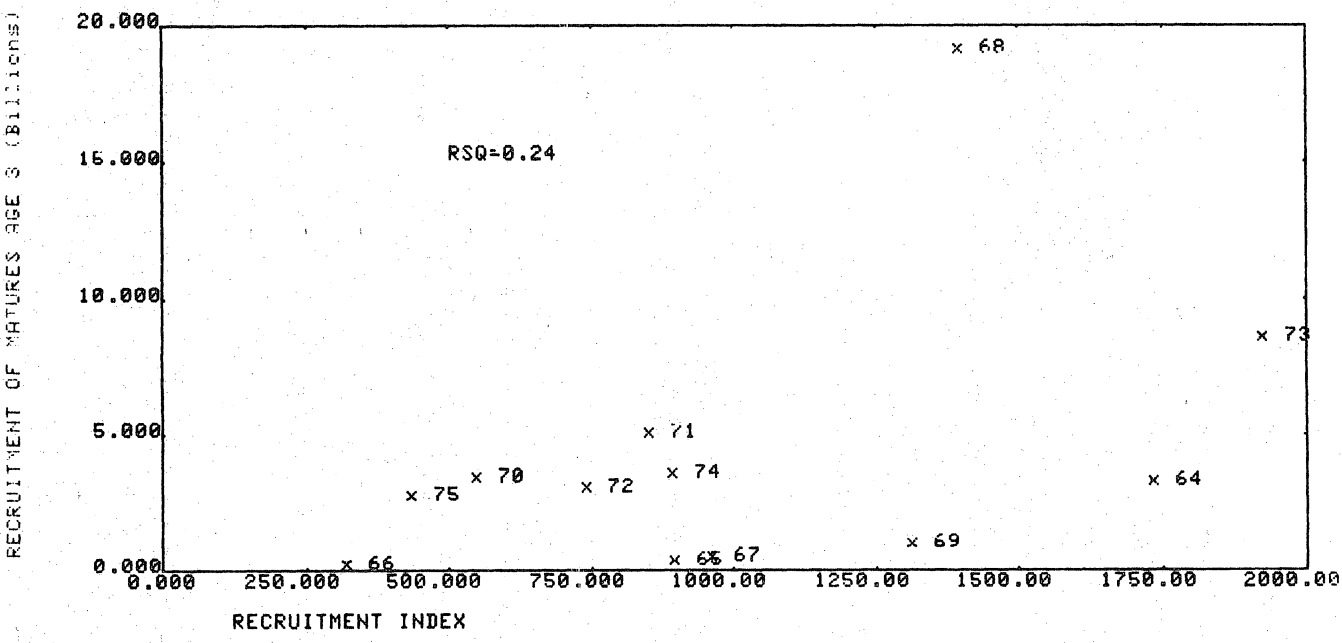

Fig. 6. Relationship between recruitment index from catch data and recruitment of mature capelin at age 3 with the value of p changed for the 1969 year-class at age 3.