Atlantic cod (*Gadus morhua*):

Assessment and Status of the Georges Bank and Gulf of Maine Stocks, January 1978

by

F. M. Serchuk, P. W. Wood, and B. E. Brown

Laboratory Reference No. 78-03
National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole, MA 02543
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Introduction

The following report presents an assessment of the status of the Georges Bank (ICNAF Div. 5Z + SA 6) and Gulf of Maine (ICNAF Div. 5Y) Atlantic cod stocks. The data and results include 1977 catch statistics, the autumn 1977 USA research survey bottom trawl abundances indices, 1978 stock size estimates, and projections for the total allowable catch in 1978 at varying levels of fishing mortality (F), and resulting 1979 stock biomass levels. Background information (pre-1977 commercial, recreational, and research data) for both stocks was summarized previously by Serchuk et al. (1977). The present report updates past assessment material and uses the results of former analyses (particularly virtual population analyses) to derive and evaluate present and future stock conditions.

Georges Bank Stock

Catch Statistics for 1977

Table 1 lists the provisional 1977 cod landings by the USA and Canada from Georges Bank, including the estimated recreational harvest. Reported USA commercial 1977 landings were 19,749 tons, a 36% increase from the 1976 catch of 14,491 tons, and the highest since 1946. Canadian catches totalled 5,434 tons, an increase of 3,130 tons from 1976, and the highest since 1969. The USA recreational harvest was assumed to be 10,000 tons, which was the estimated amount caught in 1974 (Ridgely and Deuel, MS), and also used as the 1977 recreational quota. The estimated total catch (commercial and recreational) was 35,183 tons, a 7,600 ton increase from 1976.

The reported USA commercial landings are believed to underestimate the commercial catch since informal reports by fishermen suggest that considerable quantities of scrod cod were discarded in 1977. No information

is available, however, concerning the exact amount or age composition of these discards. For the purpose of the catch and stock projections for 1978-79, four different estimates of discard levels were considered: (1) no discards (Case 1, Table 1); (2) discards equal to 15% of reported USA commercial catch (2,962 tons); (3) discards equal to 30% of reported USA commercial catch (5,925 tons); and (4) discards equal to 50% of reported USA commercial catch (9,875 tons). These estimated weights were added to the reported USA commercial catch to give different options for the 1977 landings (Cases 1-4, Table 1).

Catch Composition in 1977

Table 2 contains the estimated 1977 Georges Bank cod catch in numbers at age. These data were derived as previously described (Serchuk et al., 1977) except for the following modifications: (1) fourth quarter USA commercial length-frequency data were unavailable and, hence, the third quarter length-frequencies were used to estimate the length frequency of fourth quarter USA commercial landings; (2) the Canadian catch was assumed to be taken in the first half of the year (the Canadian directed fishery terminated on 9 August) and thus pro-rated using only the spring bottom trawl survey age-length key; and (3) the estimated discards (Cases 2-4) were distributed in ages 2 and 3 only since most reports related that scrod cod were the principal discards. The discard weights were apportioned between age groups 2 and 3 in the same ratio as the commercial weights for these ages.

The majority of the 1977 landings (Case 1-reported landings, no discards) was composed of age 2 fish (54%), with ages 2 and 3 comprising 85% of the landings. This situation contrasts sharply with the 1975 and 1976 catches in which these two age groups comprised 66% of the landings. The last time that age 2 fish exceeded 50% of the catch was in 1973 (65%).

The mean weights at age used in previous analyses (Table 3) were used to obtain the 1977-1979 stock biomass values at the beginning of each year. The observed 1977 landed catch mean weights at age (Table 4) were applied to the catch projections (numbers at age) to derive weight of catch.

Autumn 1977 Research Survey Bottom Trawl Abundance Indices

The 1977 USA autumn bottom trawl survey mean catch-per-tow indices (Table 5) revealed two different abundance changes within the Georges Bank cod population: (1) the number of fish age 2 and older (2+) increased sharply in 1977 from 1976 (4.621 vs 3.009), and was the highest value since 1973; and (2) the abundance of fish of ages 0 and 1 markedly decreased in 1977 from 1976 (0.109 vs 3.660), and was the lowest value in the history of the autumn trawl survey. These patterns result from the strong 1975 year-class, and the absence of significant recruitment from the 1976 and 1977 year-classes (Figure 1).

Annual survey length-frequency distributions of Georges Bank cod, 1971-1977,(Figure 1) illustrate the progression of the strong 1971 and 1975 year-classes through the population. The 1971 year-class was a significant component of the stock composition for four years (1971-1974). Since its appearance, the 1975 year-class has similarly comprised the bulk of the cod population. In 1977, the survey catch-per-tow (numbers) indices indicated that the 1975 year-class comprised 39% of the population. This value may be conservative, however, since faster-growing individuals may have been incorrectly deduced from the pooled age-length key (1970-1974 survey data) as age 3, rather than age 2, if recent growth rate changes have transpired.

The 1977 autumn provisional total mean catch-per-tow indices (pounds, linear and $\log_e$) were 18.8 and 1.39, respectively. Both indices declined from 1976 values (24.0 and 1.62, respectively) but were still among the higher abundance estimates observed in the survey time series (see Serchuk et al. 1977-Table 5).

Assessment Parameters in 1977 and 1978

In addition to the 1977 catch-at-age data, parameters necessary for 1978 catch projections include 1977 stock size at age, fishing mortality in 1977, size of the incoming year-classes, and estimates of partial recruitment.

Stock Size and Fishing Mortality in 1977

Stock sizes for ages 1-3 at the beginning of 1977 were obtained from regressions of survey catch-per-tow (numbers) of age 1 fish from autumn surveys versus year-class size at age 1 and age 2 from virtual population analysis (Table 6, Figures 2 and 3; for complete VPA results, see Serchuk et al. 1977- Table 9). Both relationships were derived using VPA year-class sizes calculated for 1963-1973; more recent values were excluded from regression analysis due to the marked influence of the starting F (terminal fishing mortality) on the year-class size, at age, determinations(Pope, 1972).

The size of the 1976 year-class at age 1 (beginning of 1977) was estimated to be 25.1 million fish, which would make it a slightly below-average year class (the 1960-73 mean age 1 year-class size was 30.1 million). The 1975 year-class at age 2 was estimated to be about 30.9 million fish, and is considered a strong year-class, exceeded in strength, since 1960, only by the 1966 and 1971 year-classes.

The size of the 1974 year-class at age 3 was obtained by (1) deriving the size of this year-class at age 2 from the regression of survey age 1 catch-per-tow on VPA age 2 stock size (22 million fish), and (2) applying the catches from this year-class at age 2 (in 1976 - 4.2 million fish) via the Murphy catch equation to deduce F and subsequently, the size of this year-class at the start of 1977 (age 3). This resulted in an estimated 14.1 million fish, which approximates the mean 1960-73 year-class size at age 3 (14.4 million fish).

For age groups 4 and older, stock size in 1977 was determined from the 1977 catch-at-age data, and an estimate of fishing mortality, for fully-recruited ages, from a linear relationship between fishing effort and fishing mortality. The absence, however, of an adequate measure of commercial catch-per-effort precluded calculation of actual fishing effort. Instead, an annual fishing effort index was developed (Anderson et al. 1976) by dividing total catch (in numbers) of the fully-recruited age-groups by the autumn survey catch-per-tow (numbers) of these same age groups (Table 7). Fishing effort indices for 1963-73 were regressed upon mean F values (for the fully-recruited groups) obtained from virtual population analysis.

Linear relationships were obtained using age 3+ and age 4+ groups in deriving fishing effort (Figures 4 and 5). Both regressions predicted F=0.45 for 1977 (0.45-age 3+; 0.458-age 4+). Although the coefficient of determination (r) in both regressions was not high, the predicted F values were considered realistic of the 1977 fishing mortality for age groups 4 and older. The estimated value was not applied to age 3 in 1977 since the regression between survey catch-per-tow and VPA year-class size provided

a better statistical estimate of stock size-at-age for the 1974 year-class than did the application of the estimated 1977 F to the catch data.

Partial Recruitment and Recruitment Estimates

Cod have generally been fully recruited to the Georges Bank fishery by age 3 as evidenced by age-specific fishing mortality (see Serchuk et al. 1977-Table 10). Partial recruitment at ages 1 and 2 during 1960-76 varied considerably, ranging from 0.5 to 5.8% at age 1, and 32.7 to 129.4% at age 2. For the 1978 projections, the mean values (1960-73, later values not used because of effect of starting F in the VPA) of 2.0% (age 1) and 54.0% (age 2 - excluding 1973 value) were used as selection factors.

The only available information concerning the size of the 1977 year-class is the 1977 autumn age 0 catch-per-tow index of 0.02 (Table 5). This value is the fifth lowest index in the survey series (15 observations). Although correspondence between the young-of-the-year survey abundance and VPA age 1 stock size is limited,the 1977 year-class at age 1 was assumed to be weak in strength, and set at 20 million fish. Since 1960, only three year-classes at age 1 have been poorer.

Catch and Stock Size Projections

Assessment parameters used in deriving the 1978 Georges Bank cod catch projections are summarized in Table 8. The four different cases of the estimated 1977 discards resulted in four different 1978 beginning stock sizes (biomass) from which to project 1978 catches (Table 9). For each case, four levels of 1978 fishing mortality were chosen: (1) the F value that would maintain the 1979 total stock biomass equal to 1978 total stock biomass; (2) the F value that would produce a 10% increase in 1979 total stock biomass; (3) F_{max} (F=0.30); and (4) $F_{0.1}$(F=0.18).

Table 9 lists the 1978 catch projections and the percentage changes (by weight) of the total and spawning stock biomass in 1979 from 1978. Assuming no discards occurred in 1977, a catch of 28,300 tons could be taken in 1978 and maintain the 1978 stock size in 1979 (Case 1). Alternatively, if discards equalled 50% of the reported USA commercial 1977 catch, 25,400 tons could be harvested in 1978, and still maintain the 1978 stock biomass in 1979 (Case 2). Although these two estimates of 1978 catch differ by only 3,000 tons, the difference in stock sizes is substantial (11,000 tons). To achieve a stock size in 1979 equal to that if no discards occurred in 1977 (77,500 tons), when, in fact, discards of 50% occurred in 1977 (Case 4), a catch of 16,500 in 1978 could be permitted (F_{max} option in Case 4).

Under all cases of stock biomass in 1978, a slight increase (4-5%) in spawning stock biomass in 1979 transpires when total stock size is maintained (0% increase). Consequently, slightly higher 1978 catches could be taken and still maintain the 1979 spawning biomass at the 1978 level.

Gulf of Maine Stock

Provisional 1977 cod landings from the Gulf of Maine were 10,291 tons (commercial) and 2,300 tons (assumed recreational), yielding total removals of 12,591 tons. The commercial harvest increased 4% from 1976 (9,878 tons), and was the highest in the fishery since 1945.

Size composition of the commercial landings, by market category (Table 10), in 1977 indicated that the trend (since 1974) for scrod to comprise a greater proportion of the catches continued in the present year.

Similarly, the general reduction in the percent of large cod (from 1971-73) in the catch in recent years was also evident.

Annual USA autumn bottom trawl survey length-frequency distributions of Gulf of Maine cod, 1971-1977, depict a general size-composition pattern similar to the commercial catches (Figure 6), but also indicate an absence of small cod (<20 cm) during 1976 and in 1977. Although the provisional total stratified mean catch-per-tow (numbers) (ICNAF Div. 5Y - see Serchuk et al. 1977-Table 6) index in the autumn 1977 survey increased from 1976 (3.62 vs 2.15), the 1977 value still remains one of the lower ones in the survey series. The provisional juvenile (<37 cm) catch-per-tow index in 1977 remained low (0.31 vs 0.25 in 1976) compared to the 1970-75 values, implying poor recruitment in recent years.

Since 1972, the autumn survey total catch-per-tow (pounds) indices have generally declined annually. In 1977, however, the provisional abundance indices (21.4,linear; 2.10,$\log_e$) were considerably higher than those in the immediately preceding years (see Serchuk et al. 1977-Table 5).

To evaluate the effect of fishing in 1978, the estimated population biomass during 1970-74 (28,400 tons - the mean stock size required to generate 1970-74 catches - p. 109 Fishery Management Plan for Atlantic Groundfish 1977) was adjusted to 1978, by the ratio of the 1977 survey index (21.4) to the average index observed in 1970-74 (17.34, ratio = 1.23). The resultant beginning 1978 stock size was 34,932 tons. Fishing at F_{max} (F=0.3) in 1978 would produce a catch of 8,250 tons, while fishing at $F_{0.1}$ (F=0.18) would give a 1978 catch of 5,230 tons.

In other Atlantic cod stocks, continued fishing at F levels equal to or greater than F_{max} has been accompanied by severe declines. Under conditions of average recruitment, a fishery conducted at $F_{0.1}$ will maintain a large stock size.

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Table 1. Provisional 1977 Atlantic cod landings from Georges Bank (ICNAF Div. 5Z + SA 6)[1] (metric tons).

Case[2]	USA Commercial	USA Recreational	Canada	Total
Reported (Case 1)	19,749	10,000	5,434	35,183
Case 2	22,711	10,000	5,434	38,145
Case 3	25,674	10,000	5,434	41,108
Case 4	29,624	10,000	5,434	45,058

[1]Source: US commercial landings, January-October, from New England weigh-out files; USA commercial landings, November-December, from Cod Quota Reports, Statistics Branch, NMFS. Canadian landings from ICNAF monthly provisional statistics. USA recreational landings assumed to be 10,000 tons, the amount caught in 1974 (Ridgely and Deuel, MS), and the 1977 recreational quota.

[2]Case 1 - USA commercial catch equal to US commercial reported landings (no discards).
Case 2 - USA commercial catch equal to 115% of US commercial landings (2,962 tons of discards).
Case 3 - USA commercial catch equal to 130% of US commercial landings (5,925 tons of discards).
Case 4 - USA commercial catch equal to 150% of US commercial landings (9,875 tons of discards).

Table 2. Provisional 1977 Atlantic cod catch (commercial and recreational) (thousands of fish), at age, from Georges Bank (ICNAF Div. 5Z + 6).

Case[1]	AGE 1	2	3	4	5	6	7	8	9	10	11+	Total
Case 1	303	11,287	6,397	1,657	515	325	169	137	80	38	24	20,932
Case 2	303	12,628	7,157	1,657	515	325	169	137	80	38	24	23,033
Case 3	303	13,970	7,918	1,657	515	325	169	137	80	38	24	25,136
Case 4	303	15,759	8,932	1,657	515	325	169	137	80	38	24	27,939

[1]Case 1 - USA commercial catch equal to US commercial reported landings (no discards).
Case 2 - USA commercial catch equal to 115% of US commercial landings (2,962 tons of discards)
Case 3 - USA commercial catch equal to 130% of US commercial landings (5,925 tons of discards)
Case 4 - USA commercial catch equal to 150% of US commercial landings (9,875 tons of discards)

Table 3. Mean weights at age (kg) for Atlantic cod.

Age	1	2	3	4	5	6	7	8	9	10	11
kg	.17	.62	1.41	2.51	3.88	5.45	7.15	8.93	10.75	12.55	14.31

Source: USA bottom trawl survey length-weight equation, $W_{(kg)} = e^{(-11.7231 + 3.0521 \log_e L_{(cm)})}$, and von Bertalanffy growth equation, $\ell_t = 148.1\ (1-e^{-.120(t + 0.616)})$, (Penttila and Gifford, 1976). Resultant age-weight equation is:

$$W_{t(kg)} = 34.16\ (1-e^{-1.20(t+0.616)})^{3.0521}$$

Table 4. Mean weights at age (kg) for Atlantic cod in 1977 Georges Bank landings.

Age	1	2	3	4	5	6	7	8	9	10	11
kg	0.89	1.21	1.76	2.93	4.35	5.12	7.22	8.19	9.52	10.30	11.54

Table 5. Stratified mean catch (number) per tow, by age, of Atlantic cod from USA autumn bottom trawl surveys, 1963-1977, on Georges Bank (strata 13-25).

Age Group	Year														
	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977[1]
0	.012	.006	.101	.597	.041	.039	.000	.252	.249	.730	.140	.312	1.528	.004	.020
1	.427	.367	.802	1.094	4.640	.208	.192	.746	.364	4.495	1.908	.272	.591	3.656	.189
2	.534	.499	.693	.709	1.111	1.049	.429	1.085	.434	1.019	2.789	.763	.392	1.695	1.883
3	.547	.348	.439	.314	.315	.492	.388	.639	.371	.876	1.360	.539	.595	.506	1.430
4	.515	.319	.275	.152	.218	.152	.190	.233	.278	.587	.789	.159	.576	.307	.717
5	.244	.111	.112	.059	.091	.048	.069	.069	.111	.214	.274	.063	.183	.135	.148
6	.234	.089	.112	.068	.093	.046	.055	.061	.104	.192	.243	.069	.154	.150	.119
7	.098	.030	.052	.021	.035	.018	.017	.034	.042	.075	.093	.034	.034	.065	.099
8	.076	.048	.052	.043	.028	.018	.007	.035	.034	.080	.114	.005	.013	.072	.076
9	.030	.011	.039	.007	.015	.004	.011	.018	.017	.035	.046	.015	.011	.015	.062
10	.031	.019	.024	.015	.020	.010	.009	.027	.016	.027	.055	.005	.005	.029	.043
11	.000	.013	.000	.001	.006	.006	.003	.015	.005	.000	.014	.000	.000	.008	.044
12	.015	.005	.022	.008	.010	.002	.006	.012	.008	.030	.028	.000	.000	.012	.000
13	.000	.000	.000	.000	.000	.001	.004	.000	.005	.000	.003	.000	.000	.007	.000
14	.000	.013	.000	.001	.000	.006	.000	.004	.005	.000	.014	.000	.000	.008	.000
Total	2.763	1.878	2.723	3.089	6.623	2.099	1.380	3.230	2.043	8.360	7.870	2.236	4.082	6.669	4.830

[1]Provisional.

Table 6. Stratified mean catch (number) per tow of age 1 Atlantic cod from USA autumn bottom trawl surveys on Georges Bank (strata 13-25) and year-class size (thousands of fish) at age 1 and 2 from virtual population analysis.

	Age 1		Age 2
Year-class	Autumn survey	Virtual Population analysis	Virtual Population analysis
1962	.427	25,765	21,075
1963	.367	29,518	24,207
1964	.802	31,278	25,207
1965	1.094	34,016	27,672
1966	4.640	41,249	33,560
1967	0.208	32,646	26,586
1968	0.192	19,573	15,971
1969	0.746	19,001	15,502
1970	0.364	22,086	18,011
1971	4.495	40,828	33,335
1972	1.908	26,598	---

Table 7. Estimation of fishery mortality in 1977 for the Georges Bank cod fishery, derived from relationship between fishing mortality from virtual population analysis and fishing effort derived from autumn survey catch-per-tow and total catch for age 3+ and age 4+ fish.

Year	Age 3+				Age 4+			
	Autumn survey catch/tow	Catch[1] (number) ($X10^{-3}$)	Fishing[2] effort index ($X10^{-3}$)	Mean[3] F	Autumn survey catch/tow	Catch[1] (number) ($X10^{-3}$)	Fishing[2] effort index ($X10^{-3}$)	Mean[3] F
1963	1.790	10,311	5,760	.385	1.243	5,248	4,222	.343
1964	1.006	9,057	9,003	.348	0.658	5,006	7,608	.326
1965	1.127	11,215	9,951	.447	0.688	5,434	7,898	.364
1966	0.689	12,008	17,428	.585	0.375	8,082	21,552	.717
1967	0.831	12,909	15,534	.611	0.516	5,822	11,283	.572
1968	0.803	13,964	17,390	.674	0.311	5,744	18,469	.612
1969	0.759	13,921	18,341	.678	0.371	4,990	13,450	.546
1970	1.147	10,549	9,197	.593	0.508	4,949	9,742	.546
1971	0.996	10,187	10,228	.690	0.625	5,663	9,061	.745
1972	2.116	9,338	4,413[4]	.765	1.240	4,411	3,557	.738
1973	3.033	7,062	2,328	.544	1.673	2,348	1,403	.440

[1]Includes commercial and recreational catch

[2]Catch divided by survey catch/tow

[3]Obtained from virtual population analysis assuming F=0.55 in 1976

[4]Not used due to the aberrancy of this point from the fitted line.

Table 8. Summary of parameters used in deriving 1978 stock size, by age, (1-11; in thousands of fish) of Atlantic cod from Georges Bank (ICNAF Div. 5Z+SA 6).

Age	1977 Stock size	1977 Catch	1977 Fishing Mortality(F)	1978 Stock size
1	25,114[1]	303	.0134	(20,000)[5]
2	30,948[2]	11,287	.5091	20,288
		12,628	.5902	
		13,970	.6782	
		15,759	.8085	
3	14,143[3]	6,397	.6801	15,229
		7,157	.8010	14,043
		7,918	.9375	12,860
		8,932	1.1520	11,289
4	5,008	1,657	.4500[4]	5,866
				5,198
				4,535
				3,659
5	1,556	515	.4500	2,614
6	982	325	.4500	812
7	511	169	.4500	513
8	414	137	.4500	267
9	242	80	.4500	216
10	115	38	.4500	126
11	73	24	.4500	60

[1]Calculated from regression of VPA year-class size at age 1 on autumn survey catch/tow at age 1: Y= 24450+3516.89X, r= .758.

[2]Calculated from regression of VPA year-class size at age 2 on autumn survey catch/tow at age 1: Y= 20188+2943.11X, r= .782.

[3]Calculated from catch equation iteration of derived 1976 age 2 stock size (21,927) obtained from regression of VPA year-class size at age 2 on autumn survey catch/tow at age 1: Y= 20188+2943.11X, r= .782

[4]Calculated from regressions of fishing effort on mean fishing mortality for age 3+ and age 4+ fish (see text).

[5]Assumed (see text).

Table 9. Projected Atlantic cod catch in 1978 from the Georges Bank stock (ICNAF Div. 5Z+SA 6) under four cases concerning the estimated 1978 stock size (derived from four estimates of the 1977 US commercial catch). The 1978 fishing mortality values were chosen to provide catches in 1978 that would (1) maintain the stock size, (2) produce a 10% increase in total stock size; and give changes at F_{max} and $F_{0.1}$. Total stock sizes (age 1+) and spawning stock sizes (age 3+) in 1978 and the percentage changes (by weight) from 1978 are also given. All catch and stock sizes are in metric tons.

	1978			1979		% Change in	
	Total stock size	Spawning stock size	1978 Catch (tons)	Total stock size	Spawning stock size	Total stock size	Spawning stock size
Case 1	77,557	61,578					
0% (F=.499)			28,337	77,569	64,118	0.0	+ 4.1
10% (F=.369)			22,098	85,315	71,837	+10.0	+16.7
F_{max} (F=.300)			18,497	89,818	76,326	+15.8	+24.0
$F_{0.1}$ (F=.180)			11,681	98,367	84,851	+26.8	+37.8
Case 2	74,208	58,229					
0% (F=.510)			27,453	74,218	60,769	0.0	+ 4.4
10% (F=.378)			21,470	81,624	68,148	+10.0	+17.0
F_{max} (F=.300)			17,606	86,440	72,948	+16.5	+25.3
$F_{0.1}$ (F=.180)			11,115	94,559	81,043	+27.4	+39.2
Case 3	70,876	54,897					
0% (F=.522)			26,480	70,896	57,449	0.0	+ 4.6
10% (F=.388)			20,844	77,953	64,479	+10.0	+17.5
F_{max} (F=.300)			16,721	83,079	69,587	+17.2	+26.8
$F_{0.1}$ (F=.180)			10,554	90,769	77,253	+28.1	+40.7
Case 4	66,462	50,483					
0% (F=.541)			25,427	66,463	53,020	0.0	+ 5.0
10% (F=.403)			20,011	73,102	59,631	+10.0	+18.1
F_{max} (F=.300)			15,547	78,626	65,134	+18.3	+29.0
$F_{0.1}$ (F=.180)			9,810	85,748	72,232	+29.0	+43.1

Table 10. Distribution of Gulf of Maine (ICNAF Div. 5Y) Atlantic cod landings, 1971-1977, by market category: landings in metric tons, live weight.

Year		Market Category[1]					Total
		Whale	Large	Market	Scrod	Mixed	
1971		0.6	3,738	3,006	448	-	7,192
	%	-	52	42	6	-	
1972		1.0	3,933	2,365	487	-	6,785
	%	-	58	35	7	-	
1973		0.8	3,161	2,205	687	8	6,061
	%	-	52	36	11	-	
1974		-	2,891	2,428	2,097	9	7,424
	%	-	39	33	28	-	
1975		0.2	2,803	3,613	2,340	19	8,675
	%	-	32	42	26	-	
1976		0.5	2,856	4,466	1,932	623	9,876
	%	-	29	45	20	6	
1977[2]		-	3,506	4,341	2,124	320	10,291
	%	-	34	42	21	3	

[1]Scrod: 1.5-2.5 lbs.
Market: 2.5-10.0 lbs
Large: >10.0-25 lbs
Whale: >25 lbs

[2]November-December landings prorated into market categories on the basis of January-October ratios.

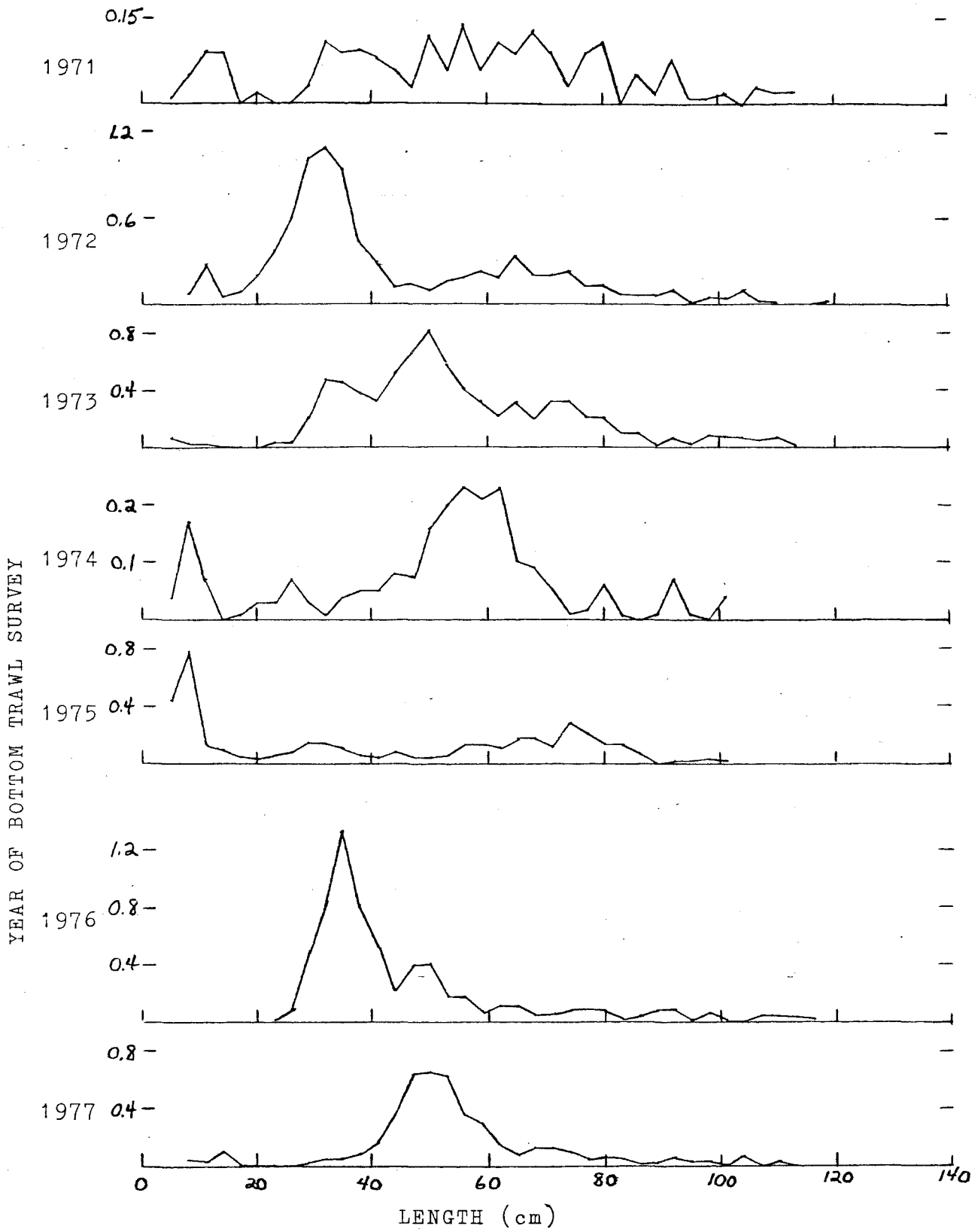


Figure 1. Length-frequency distributions (stratified mean number per tow by length category) of cod from Georges Bank (strata 13-25) from USA autumn bottom trawl surveys, 1971-1977.

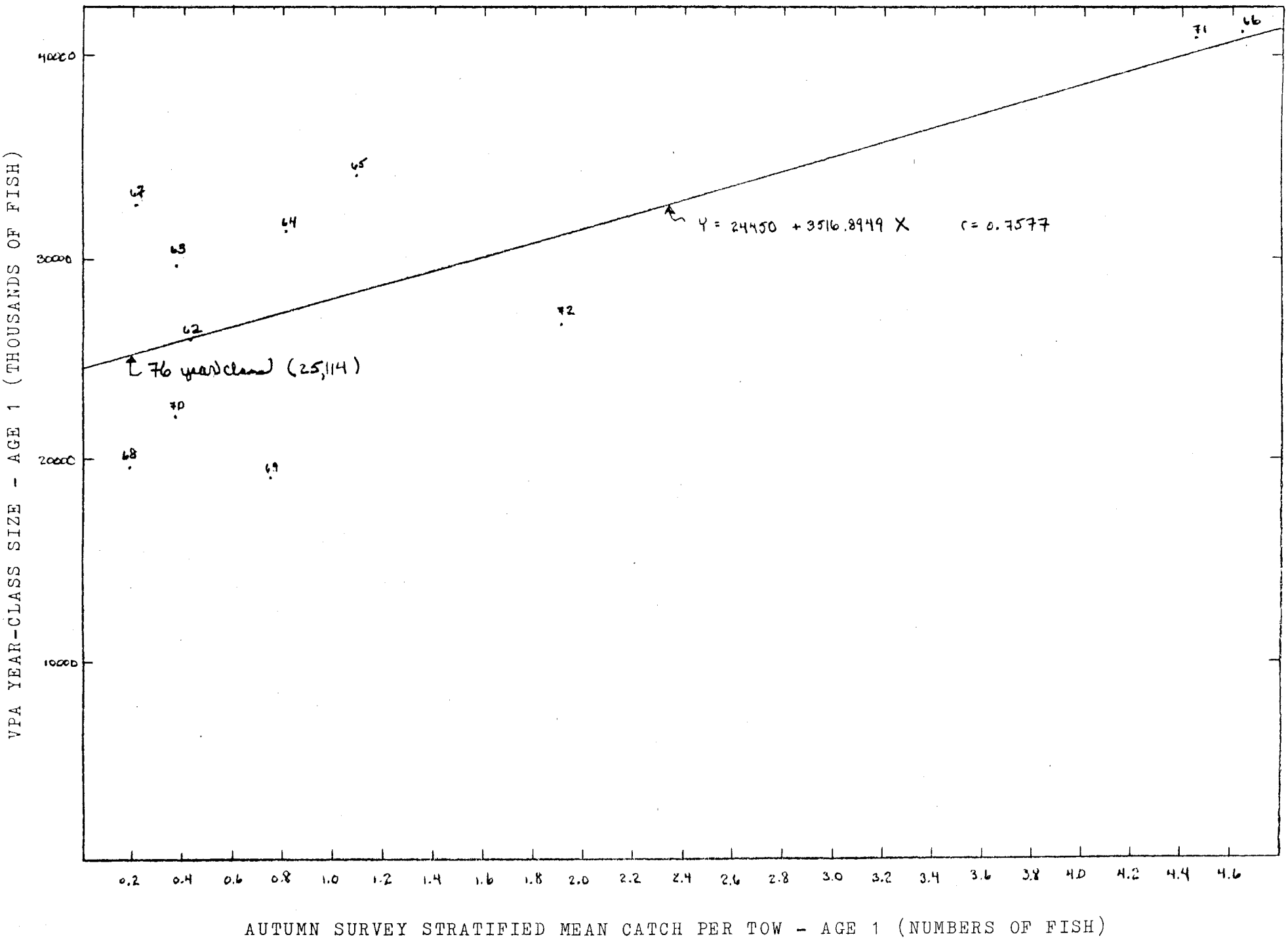


Figure 2. Relationship between Georges Bank cod year-class size at age 1 and autumn survey catch-per-tow at age 1

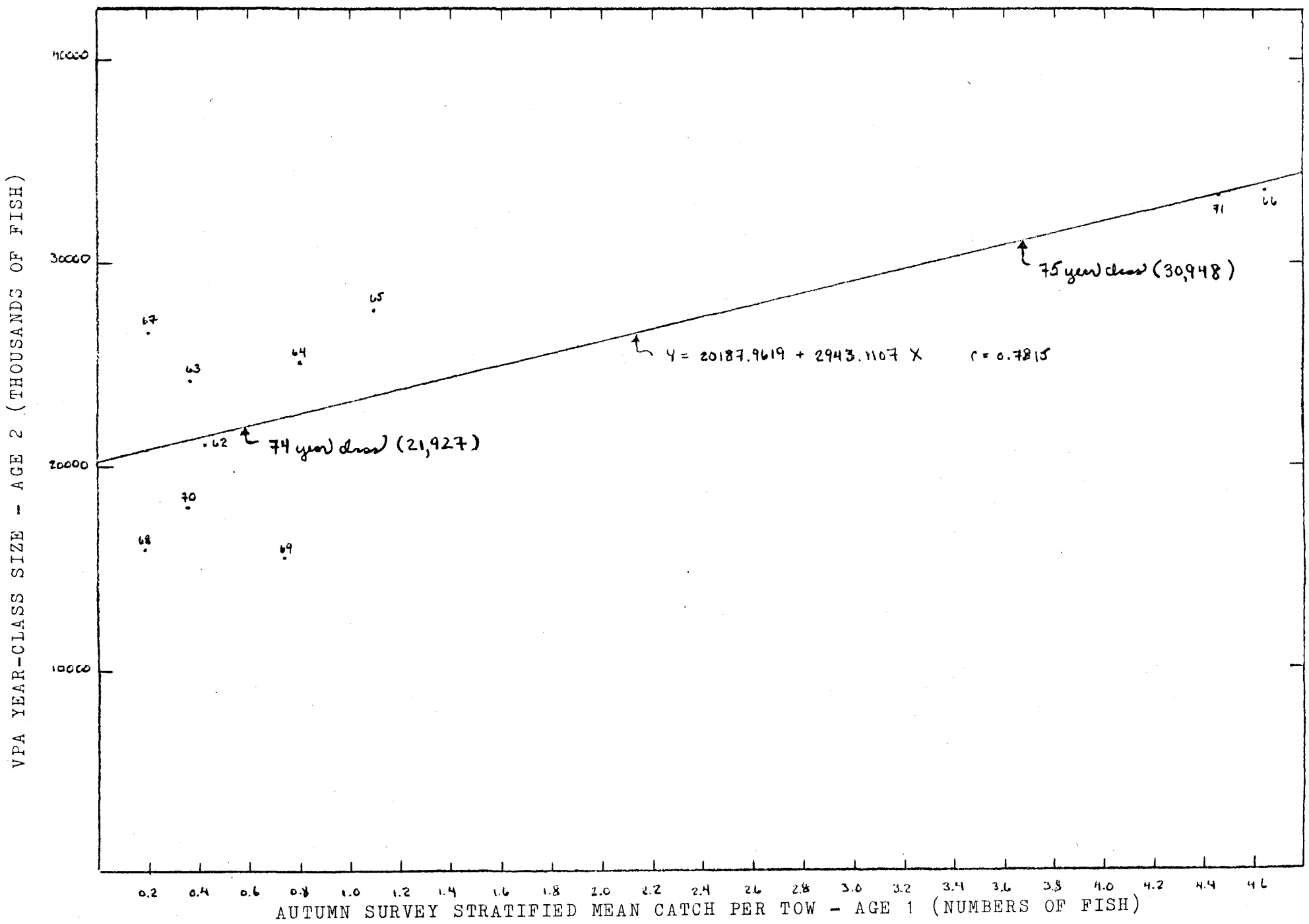


Figure 3. Relationship between Georges Bank cod year-class size at age 2 and autumn survey catch-per-tow at age 1.

Figure 4. Relationship between fishing mortality for fully recruited cod (age 3 and older) derived from VPA and fishing effort derived from autumn catch-per-tow (age 3+) and total catch (age 3+).

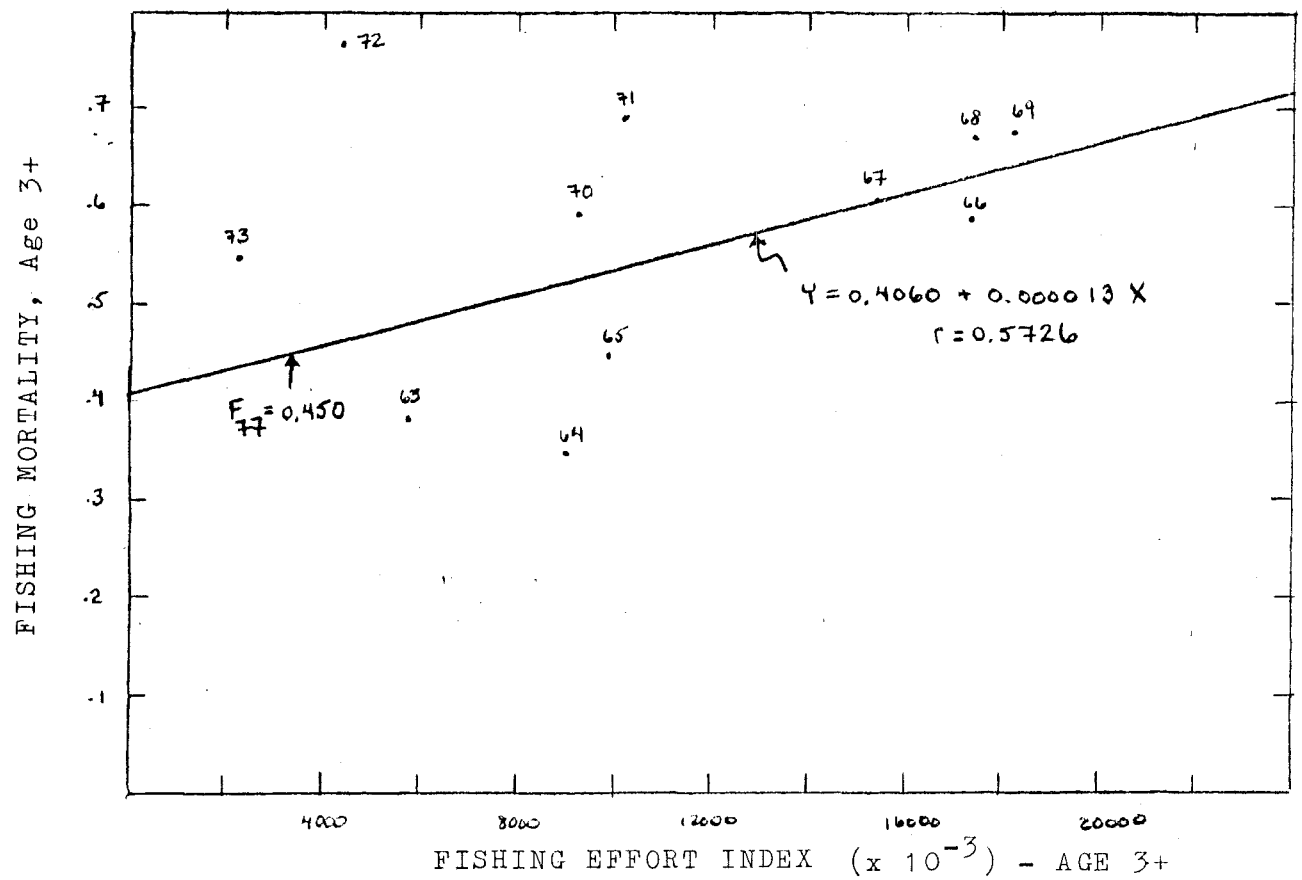
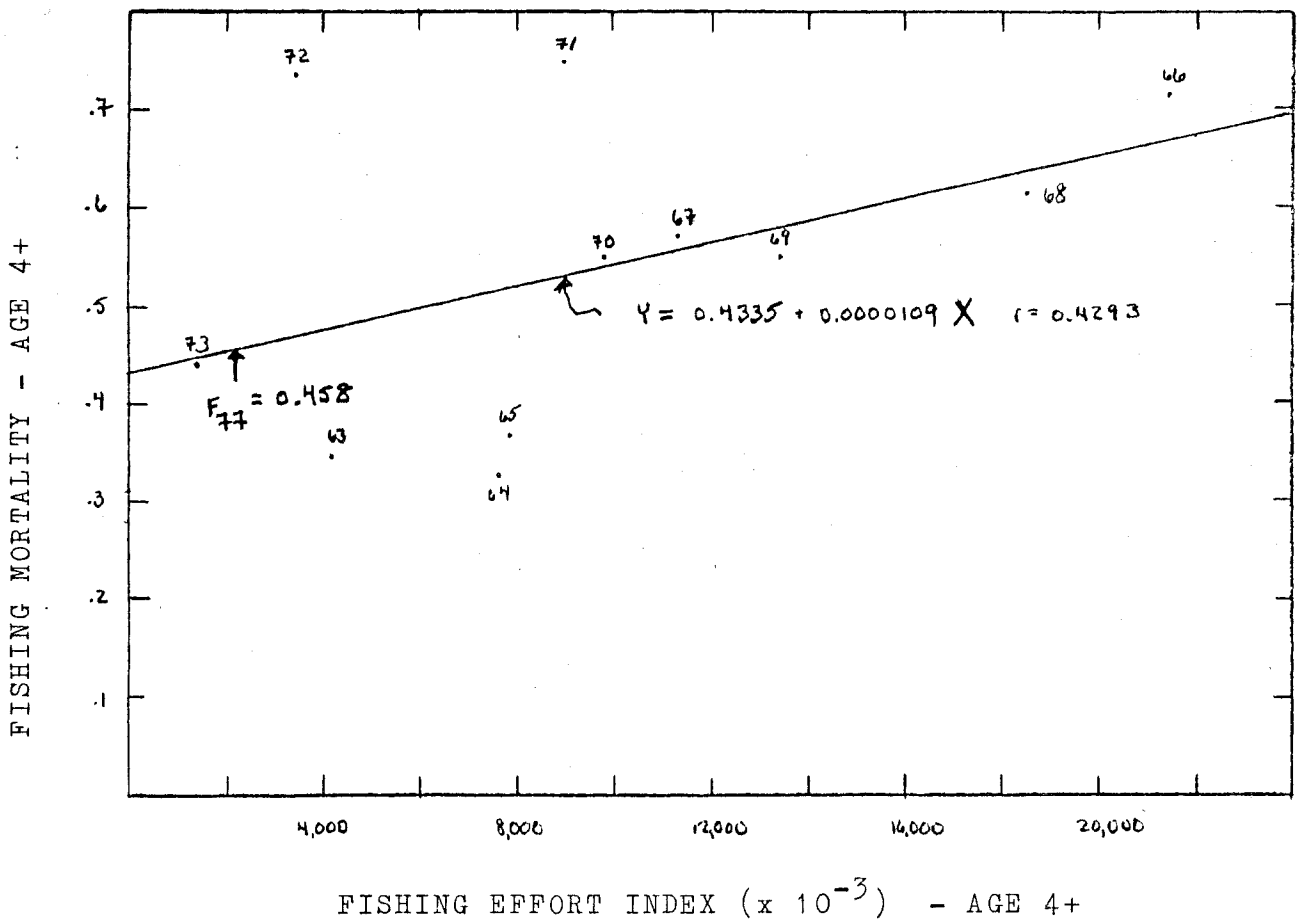


Figure 5. Relationship between fishing mortality for fully recruited cod (age 4 and older) derived from VPA and fishing effort derived from autumn catch-per-tow (age 4+) and total catch (age 4+).



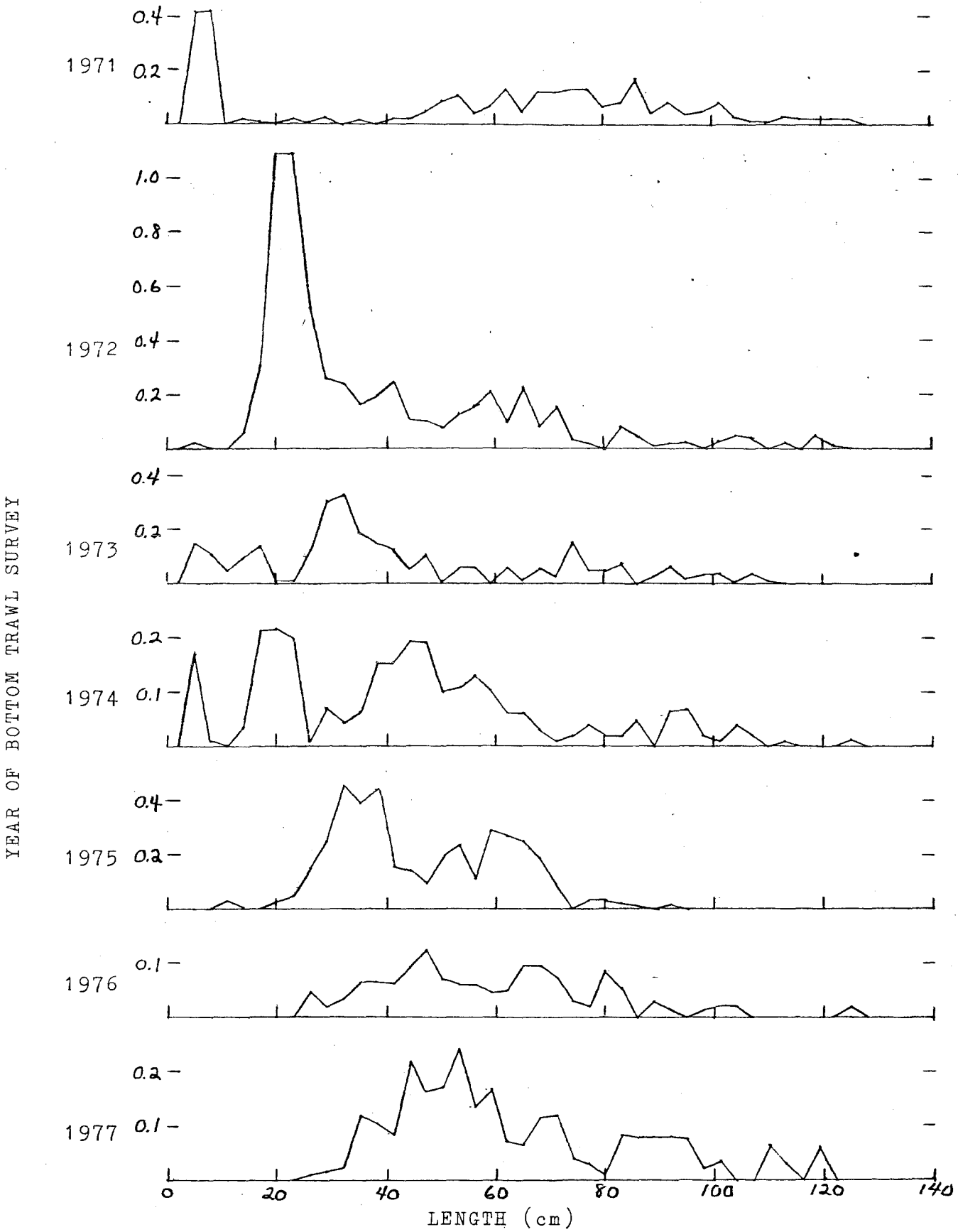


Figure 6. Length-frequency distributions (stratified mean number per tow by length category) of cod from the Gulf of Maine (strata 26-30; 36-40) from USA autumn bottom trawl surveys, 1971-1977.