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Preliminary Assessment of Winter Flounder (*Pseudopleuronectes americanus* Walbaum) on Georges Bank

by

Wendy L. Gabriel and Karen L. Foster

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Vaughn C Anthony

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National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole Laboratory
Woods Hole, Massachusetts 02543

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SUMMARY

Commercial landings of 2,150 mt in 1985 are 45% lower than 1983-1984 levels, and 40% lower than the 1979-1984 average. Recent effort has reached record high levels. Commercial catch-per-unit effort indices show a rapid decline from the 1981 peak to historical low levels in 1984-1985. Since 1983, size composition of the catch has shifted toward smaller fish. Although aggregate research vessel survey indices of abundance show no clear trend, some disaggregate indices decreased in 1985 and 1986. The stock is likely to be overexploited, based on these indicators.

INTRODUCTION

Winter flounder is a small but regular component of the Georges Bank multispecies trawl fishery, contributing between 2,000 - 4,000 mt annually to landings by U.S. fishermen. Assessment information is necessary to support management of this stock under the New England Fishery Management Council's Northeast Multispecies Fishery Management Plan.

This document summarizes historical trends in catch, effort and currently available indices of relative abundance of the Georges Bank stock of winter flounder, updating an earlier review by Lange and Lux (1978).

BIOLOGY OF STOCK

Stock Area Definition

The Georges Bank stock has long been differentiated from inshore stocks by its higher growth rate: at one point, the stock was defined as a separate species (*Pseudopleuronectes dignabilis* Kendall, 1912) based on size (Bigelow and Schroeder, 1953). Fin ray counts differ between fish from Georges Bank and inshore (Perlmutter, 1947; Lux et al., 1970). Spawning occurs on the Bank and larvae and juveniles remain there, geographically separated from inshore populations (Lux et al., 1970; Klein-MacPhee, 1978). Tagging studies (Coates et al., 1970) indicate little mixing between Georges Bank and inshore areas. Although the depth of the South Channel alone would not necessarily prohibit east-west movement, the proportion of fish tagged on Georges Bank that were recaptured west of the Channel was low (<2%). Consequently, U.S. statistical reporting areas 522-525 (Figure 1) and Northeast Fisheries Center offshore bottom trawl survey sampling strata 13-22 (Figure 2) were identified as corresponding to the Georges Bank stock area, bounded to the west by the South Channel.

Life History Parameters

A detailed synopsis of available biological data for winter flounder was assembled by Klein-MacPhee (1978). The most recently published growth curves for the stock were developed by Lux (1973). Coates et al. (1970) estimated total instantaneous mortality rate (Z) as 0.26, with instantaneous fishing mortality rate (F) of 0.17 and instantaneous natural mortality rate (M) of 0.09, from tagging studies. Most other published estimates of life history parameters have not been stock-specific.

COMMERCIAL FISHERY

Catch and Effort Patterns

Domestic landings last year dropped by the largest percentage ever observed for the fishery. Landings of 2,150 mt in 1985 by U.S. fishermen were 40% lower than the 1979-1984 average (3,645 mt) and 45% lower than 1983-1984 levels. Landings had increased from 1,400 mt in 1964 to 3,100 mt in 1971, and afterward declined until 1976. Recent 1977-1984 levels almost always exceeded 3,000 mt, however.

Historical foreign landings of winter flounder from Georges Bank are difficult to estimate, but appear relatively minor compared to U.S. landings (Table 1, Figures 3 and 4). Recent (1968-1985) Canadian landings from North Atlantic Fisheries Organization (NAFO) area 5ZE (aggregated over U.S. statistical reporting areas 521-526; 541-543) have never exceeded 65 mt, and were approximately 11 mt in 1985. Between 1968-1975, landings by the USSR from area 5ZE averaged 580 mt, with a peak of 1,700 mt in 1972. (U.S. landings from area 5ZE between 1968-1975 averaged 6,968 mt, with a peak of 14,000 mt in 1971.) However, area 5ZE includes statistical areas 521 and 526, in which winter flounder are abundant but are considered to be different stocks. Thus, actual foreign landings from the Georges Bank stock area are lower than the 5ZE total by an unknown amount.

Although USA otter trawlers between 51-150 GRT land most of the winter flounder caught, larger vessels have recently played a more important role (Table 2). The proportion of catch by vessels 150-500 GRT (class 4) was significant in the 1960's but declined overall until 1980. Between 1981 and 1985, however, the proportion of total catch landed by class 4 vessels nearly doubled, from 20% to 39%. The small proportions of total catch generated by the smallest trawlers (50 GRT or less, class 2) shrank to negligible levels by 1969.

USA effort leading to any winter flounder landings in 1984-1985 has been at record high levels (Table 3). For class 3 vessels, effort had been increasing to a peak in 1977, dropped 28% to a low in 1979, but surged upward by 50% between 1983 and 1984. For class 4 vessels, recent peaks represent a continuation of an increasing trend in effort since 1976. Over that period, effort increased fivefold. While trip length (days fished per trip) dropped somewhat during 1979-1981, it has subsequently increased to record or near record highs. Effort directed toward winter flounder has shown similar trends (Table 4). Directed effort by class 3 vessels (based on trips where landings comprise $\geq$20% and $\geq$50% winter flounderby weight) has increased steadily since 1964. Directed effort by class 4 vessels has increased about fourfold since 1982. Both effort and trip length within these more directed components of the fishery were at record high levels in 1984-1985.

The fishery for winter flounder has become increasingly directed over time (Table 5). Between 1964-1970, 9-27% of total landings by vessel class 3 came from highly directed trips (from which $\geq$50% of the trip landings were winter flounder), but by 1983, that proportion had increased to about 50%. This percentage has dropped somewhat in 1984-1985, however. The vessel class 4 fishery underwent its first period of an increasingly directed fishery from

1966-1976, and a second from 1978-1982. Currently, about 25% of the landings by this vessel class come from highly directed trips.

Catch-per-unit-effort analysis

Catch-per-unit-effort indices (CPUE) based on simple ratios of landings per days fished showed substantial declines in 1984 and 1985 for all components of vessel class 3 and 4 fisheries (Table 6). Many indices showed declines after peaks in 1980 (e.g., indices based on all trip, trips $\geq$20% and trips $\geq$50%, vessel class 3; trips $\geq$20%, trips $\geq$50%, vessel class 4). However, 1984 indices in nearly all cases were the second lowest ever observed for all directed fisheries by vessel classes 3 and 4, while associated 1985 indices were universally the lowest.

In an exploratory analysis to adjust annual CPUE indices for effects of variability due to vessel tonnage class, season, location and depth, the regression coefficient index of relative abundance (Kimura, 1981) was obtained as a preliminary measure of adjusted CPUE (the "naive estimator": Bradu and Mundlak, 1970) from standard multiplicative models (Robson, 1966; Kimura, 1981). The reference cell (Table 7) was defined from second quarter landings in 1983 by tonnage class 33 vessels, area 524, depth zone 3, with observations from interviewed trips only. Combinations of up to five main effects [year, vessel tonnage class, calendar quarter, statistical area, and depth (Table 7)] were evaluated to find an appropriate model. Interactions, although statistically significant due to large sample sizes, usually had F values an order of magnitude smaller than those of main effects, and were omitted from further analysis. Values of R^2 were generally low for all models, although addition of main effects ("extra sums of squares") were usually significant, also because of very large numbers of observations. Values of F began to decline after three effects were added, however. Within the set of three effect models, "best" models were chosen based on highest F and significance levels of effects included. The best three effect models of catch per day fished from trips in which 20% or more of the landings were winter flounder ("20% data set") included effects of year, depth, and tonnage class, or year, depth and area (Table 8). The best three effect models for trips in which 50% or more of the landings were winter flounder ("50% data set") included effects of year, tonnage class, and quarter; or year, tonnage class, and depth (Table 9). The differences in patterns of relative CPUE between alternate models for a data set were negligible (Tables 10 and 11, Figures 5 and 6) which would be expected based on the relatively small increase in R^2 observed when including additional effects: alternative models were effectively indistinguishable. Patterns from the 20% data set were generally smoother, with less intense annual peaks than patterns from the 50% set. Residuals were approximately normally distributed (Kolomogorov-Smirnov test, $\alpha = 0.001$).

From the 20% data set, a slight downward trend appeared from 1964-1976, followed by an increase from 1976-1981, and then a rapid decline from the 1980 peak to lowest observed levels in 1984-1985 (Figure 5). The first two trends were much less visible from the 50% data set, but the rapid decline in relative CPUE since 1981 to lowest observed levels in 1984-1985 was clear (Figure 6). Results were basically the same as trends described from the raw CPUE data set.

Size Composition of Commercial Catch

There has been a substantial shift in size composition of the commercial catch by market category after 1975 and again after 1982 toward smaller fish (Table 12). Lemon sole, the largest size category, constituted at least 28% of the total landings annually from 1964-1975. The fraction of catch composed of lemon sole declined markedly in 1976 and again in 1977, and averaged 19% of the catch from 1977 to 1982. Most recently this has dropped to 9-12%. This does not appear to be a function of a change in the market category structure over time, as there was no significant compensatory increase in the fraction of catch landed as large, large/mix or extra large fish (which would have indicated fish previously categorized as lemon sole were now categorized as a smaller type). At the same time, commercial catch showed complementary increases in relative and absolute amounts of winter flounder landed as small and most recently, peewee-sized fish.

RESEARCH VESSEL SURVEYS

Relative Abundance Indices

Standard indices of abundance and biomass from NEFC research vessel surveys (stratified mean catch/tow, strata 13-22) have generally fluctuated without trend (Table 13, Figures 7 and 8), and do not show consistent patterns from season to season or year to year. The autumn time series appears to show low abundances in the early 1970's, an increase in the later 1970's and some decrease since then. The spring index suggests a decline from a peak in 1983 to lower levels in 1986. Most survey catches were obtained from strata 19-20, and secondarily from stratum 16.

Difficulty in interpreting survey fluctuations may be attributable to interannual differences in availability or distribution with respect to survey stations. The aggregate survey index sometimes did not reflect consistent sampling of the stock, based on inspection of length frequency distributions (Figures 9 and 10). Although plots of length frequency by single centimeter intervals do not allow the easiest identification of modes, the distribution of lengths in the stock based on the spring survey series showed few consistent patterns (Figure 9). The problems were also reflected in the fall series (Figure 10): the peak reflecting young-of-year abundance in 1975 (at approximately 7 cm) was not observed at age 1 in 1976 (expected near 25-27 cm in September). Likewise, a strong peak observed near 35 cm in 1976, representing age 2 fish, was not observed in 1975 at age 1. While some year classes could be followed as modes (e.g., 1979, 1980, 1981, 1983), most could not, especially in earlier years. Few fish five years and older (over 50 cm) were caught.

Relationship to Commercial Indices

Not surprisingly, correlations between aggregated research survey indices and commercial catch-per-unit-effort indices were poor (Table 14). Correlations were strongest for fall indices, disaggregated by single strata. Removal of fish below minimum landed sizes (27 cm) from the survey index did not improve the relationship ($r = 0.07$), although this relationship

compared number (survey) with biomass (CPUE) based indices. The strongest relationship was observed between log transformed mean catch per tow from stratum 20 and (log) CPUE indices based on 20% trips. This log - log relationship was not highly significant (= 0.15), and appeared to be driven primarily by concurrent very sharp decreases in recent years (Figure 11). Both indices showed a variable declining trend from the mid-60's to the mid-70's, followed by some increase, and then a decline to present historical low levels. (The 1985 autumn survey represented the first time that no winter flounder were caught in stratum 20.)

DISCUSSION

Recent sharp declines in commercial catch per unit effort and some research survey indices indicate a likely recent decline in stock abundance. Fish first landed at 27 cm in the peewee market category are approximately 50% sexually mature (Morse, 1979), and would not have been fully mature until spawning at age 3: thus, a fair proportion of fish landed in smaller commercial market categories are not sexually mature. Primarily four age classes appear to comprise the Georges Bank population as evidenced from recent research surveys (from approximations based on Lux, 1973), thus, fish may spawn twice over a life span. Firmer conclusions, however, cannot be made until more detailed analysis of length and age composition of commercial catches has been completed.

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Table 1. Commercial nominal catch (metric tons) of winter flounder including Georges Bank areas, 1962-1985.

	522-525	5Z(521-543)				5ZE(521-526,541-543)				5NK
Year	USA	USA	Canada	USSR	Total	USA	Canada	USSR	Total	USA
1962		6996	26		7022					18
1963		6911	120	19	7050					
1964	1371	12656	146		12802					
1965	1473	10479	199	312	10990					
1966	1876	13807	164	156	14127					
1967	1916	10815	89	349	11253					
1968	1569					4346	59	372	4777	
1969	2165					6380		235	6615	
1970	2613					7020	64	40	7124	
1971	3090					14000	65	1029	15094	
1972	2803					10266	8	1699	11973	
1973	2267					4387	14	693	5094	
1974	2122					4508	12	82	4602	
1975	2413					4833	13	515	5361	50
1976	1877					3732	11	1	3744	54
1977	3569					5954	15	7	5976	123
1978	3190					6378	65		6443	118
1979	3083					6293	19		6312	96
1980	3954					9941	44		9985	63
1981	4055					9711	19		9730	62
1982	2961					7347	19		7366	144
1983	3894					8014	14		8028	153
1984	3928					7574	4[1]		7578[1]	
1985	2152					4758	11[1]		4769[1]	

[1]Preliminary.

Table 2. Percentage distribution of USA commercial landings (metric tons, live) of winter flounder by gear type and vessel tonnage class[1], from Georges Bank (USA Statistical Reporting Areas 522-525), 1964-1985.

	Otter Trawl			Scallop Dredge	
Year	Class 2	Class 3	Class 4	Classes 3-4	Other
1964	5.4	67.7	26.1	0.8	
1965	4.6	60.1	35.2	0.1	
1966	2.9	62.2	33.6	0.2	1.1
1967	2.4	56.0	41.4	0.2	
1968	2.2	66.2	31.3	0.3	
1969	0.3	71.2	28.4	0.1	
1970	0.6	76.6	22.6	0.2	
1971	2.2	73.8	23.8	0.2	
1972	1.3	79.6	18.8	0.3	
1973	1.0	76.1	22.8	0.1	
1974	0.7	72.1	26.8	0.4	
1975	0.4	77.0	22.6	-	
1976	0.2	79.2	20.6	<0.1	
1977	0.9	81.2	17.8	0.1	
1978	0.3	79.8	19.3	0.6	
1979	1.1	80.0	18.0	0.9	
1980	1.8	79.2	17.9	1.1	
1981	0.7	77.3	20.6	1.4	
1982	1.1	74.1	23.4	1.4	
1983	0.3	67.8	31.3	0.6	
1984	0.2	64.9	34.3	0.5	0.1
1985	0.2	61.2	38.5	0.1	

[1]Class 2: 5-50 GRT; Class 3: 51-150 GRT; Class 4: 151-500 GRT.

Table 3. USA commercial vessel trips, days fished, and average days fished per trip, by vessel tonnage class (Class 2: 5-50 GRT; Class 3: 51-150 GRT; Class 4: 151-500 GRT) for otter trawl trips landing winter flounder from Georges Bank (Areas 522-525), 1964-1985.

	Class 2			Class 3			Class 4			Total		
Year	Total trips	Days fished	Days fished per trip	Total trips	Days fished	Days fished per trip	Total trips	Days fished	Days fished per trip	Total trips	Days fished	Days fished per trip
					All trips							
1964	98	350	3.57	739	3101	4.20	345	2297	6.66	1182	5748	4.86
1965	71	280	3.94	780	3652	4.68	412	2782	6.75	1263	6714	5.32
1966	54	216	4.00	795	3798	4.78	421	2766	6.57	1269	6780	5.34
1967	35	142	4.06	683	3187	4.67	363	2268	6.25	1081	5596	5.18
1968	31	120	3.87	740	3518	4.75	250	1521	6.08	1021	5159	5.05
1969	17	49	2.88	917	4147	4.52	248	1404	5.66	1182	5600	4.74
1970	17	55	3.24	980	4380	4.47	225	1142	5.07	1122	5576	4.56
1971	48	162	3.38	1139	5046	4.43	253	1351	5.34	1440	6558	4.55
1972	27	103	3.81	1132	5239	4.63	229	1118	4.88	1389	6461	4.65
1973	25	99	3.96	868	4084	4.70	190	906	4.77	1083	5089	4.70
1974	21	72	3.43	1065	5170	4.85	244	1231	5.04	1330	6473	4.87
1975	20	52	2.60	1094	5316	4.86	221	1076	4.87	1335	6445	4.83
1976	9	24	2.67	910	4992	5.48	116	607	5.23	1036	5624	5.43
1977	26	103	3.96	1091	5548	5.08	155	728	4.70	1272	6379	5.01
1978	39	48	1.23	890	4496	5.05	171	798	4.67	1100	5342	4.86
1979	46	120	2.61	955	3992	4.18	226	948	4.19	1227	5060	4.12
1980	50	148	2.96	1091	4182	3.83	328	1241	3.78	1469	5571	3.79
1981	60	134	2.23	1117	4369	3.91	477	1836	3.85	1654	6340	3.83
1982	23	72	3.13	992	4450	4.48	396	1820	4.60	1412	6348	4.49
1983	6	22	3.67	886	4336	4.89	486	2408	4.95	1378	6766	4.91
1984	9	24	2.67	1209	6468	5.35	629	3319	5.28	1846	9812	5.31
1985	8	30	3.75	939	5396	5.75	481	2671	5.55	1428	8096	5.67

Table 4. USA commercial vessel trips, days fished and average days fished per trip, by vessel tonnage class (Class 2: 5-50 GRT; Class 3: 51-150 GRT, Class 4: 151-500 GRT) for otter trawl trips in which winter flounder comprised 20% or more and 50% or more of the total trip catch, by weight directed, highly directed trips, respectively).

	Class 2			Class 3			Class 4			Totals		
Year	Total trips	Days fished	Days fished per trip	Total trips	Days fished	Days fished per trip	Total trips	Days fished	Days fished per trip	Total trips	Days fished	Days fished per trip
							≥20% trips					
1964	10	28	2.80	70	226	3.23	5	10	2.00	85	264	3.10
1965	10	39	3.90	77	258	3.35	6	22	3.67	93	319	3.43
1966	6	22	3.67	108	392	3.63	19	66	3.47	133	480	3.61
1967	10	28	2.80	123	452	3.67	43	163	3.79	176	643	3.65
1968	6	26	4.33	96	373	3.88	23	89	3.87	125	488	3.90
1969	1	3	3.00	107	406	3.79	30	95	3.17	138	504	3.65
1970	1	2	2.00	234	842	3.60	61	221	3.62	296	1065	3.60
1971	11	32	2.91	290	1131	3.90	75	320	4.27	376	1483	3.94
1972	5	21	4.20	303	1259	4.16	71	282	3.97	379	1562	4.12
1973	5	18	3.60	230	924	4.02	75	276	3.68	310	1218	3.93
1974	4	10	2.50	219	884	4.04	80	311	3.89	303	1205	3.98
1975	4	10	2.50	311	1249	4.02	98	329	3.36	413	1588	3.84
1976	1	1	1.00	232	888	3.83	63	256	4.06	296	1145	3.87
1977	8	28	3.50	425	1584	3.73	87	334	3.84	520	1946	3.74
1978	4	20	5.00	394	1371	3.48	64	191	2.98	462	1582	3.42
1979	10	28	2.80	440	1294	2.94	63	167	2.65	513	1489	2.90
1980	21	66	3.14	515	1622	3.15	71	154	2.17	607	1842	3.03
1981	13	21	1.62	515	1727	3.35	93	261	2.81	621	2009	3.24
1982	10	35	3.50	356	1299	3.65	68	235	3.46	434	1569	3.62
1983	3	12	4.00	394	1639	4.16	134	534	3.98	531	2185	4.11
1984	4	9	2.25	539	2568	4.76	198	883	4.46	741	3460	4.67
1985	2	10	5.00	366	1800	4.92	146	737	5.05	514	2547	4.95
							≥50% trips					
1964	3	5	1.67	25	66	2.64	3	7	2.33	31	78	2.52
1965	0	0	0.00	34	98	2.88	3	8	2.67	37	106	2.86
1966	1	2	2.00	18	52	2.89	1	2	2.00	20	56	2.80
1967	1	4	4.00	29	96	3.31	5	14	2.80	35	114	3.26
1968	3	14	4.67	25	90	3.60	4	9	2.25	32	113	3.53
1969	0	0	0.00	20	61	3.05	10	24	2.40	30	85	2.83
1970	0	0	0.00	58	186	3.21	10	30	3.00	68	216	3.18
1971	4	14	3.50	66	212	3.21	17	61	3.59	87	287	3.30
1972	2	7	3.50	74	267	3.61	14	47	3.36	90	321	3.57
1973	0	0	0.00	68	251	3.69	17	45	2.65	85	296	3.48
1974	0	0	0.00	51	174	3.41	20	52	2.60	71	226	3.18
1975	2	4	2.00	112	381	3.40	30	84	2.80	144	469	3.26
1976	0	0	0.00	91	302	3.32	24	90	3.75	115	392	3.41
1977	2	6	3.00	106	328	3.09	22	74	3.36	130	408	3.14
1978	1	6	6.00	122	340	2.79	11	25	2.27	134	371	2.77
1979	2	5	2.50	143	398	2.78	15	23	1.53	160	426	2.66
1980	5	18	3.60	199	642	3.23	21	36	1.71	225	696	3.09
1981	2	3	1.50	202	670	3.32	25	58	2.32	229	731	3.19
1982	1	6	6.00	144	548	3.80	23	68	2.96	168	622	3.70
1983	1	7	7.00	187	730	3.90	42	128	3.05	230	865	3.76
1984	2	4	2.00	213	938	4.40	70	267	3.81	285	1209	4.24
1985	0	0	0.00	143	701	4.90	56	262	4.68	199	963	4.84

Table 5. Percentage, within vessel tonnage class, of vessel class winter flounder landings (L), vessel trips (T), and effort (DF) of otter trawlers landing winter flounder from Georges Bank (522-525) in which winter flounder comprised 20% (or more) or 50% (or more) of trip catch weight (directed, highly directed trip).

Year	Class 2			Class 3			Class 4			Total		
	L	T	DF	L	T	DF	L	T	DF	L	T	DF
							>20%					
1964	40.5	10.2	8.0	35.7	9.5	7.3	8.4	1.4	0.4	28.8	7.2	4.6
1965	44.1	14.1	13.9	45.1	9.9	7.1	7.7	1.4	0.8	31.9	7.4	4.8
1966	33.3	11.1	10.2	45.6	13.0	10.3	8.7	4.5	2.4	32.7	10.5	7.1
1967	56.5	28.6	19.7	49.2	18.0	14.2	28.2	11.8	7.2	40.6	16.3	11.5
1968	41.2	19.4	21.7	42.5	13.0	10.6	22.4	9.2	5.8	36.2	12.2	9.4
1969	14.3	5.9	6.1	34.3	11.7	9.8	26.3	12.1	6.8	31.9	11.7	9.0
1970	12.5	5.9	3.6	61.3	23.9	19.2	55.1	27.1	19.3	59.6	24.2	19.1
1971	65.7	22.9	19.7	62.5	25.5	22.4	52.8	29.6	23.7	60.2	26.1	22.6
1972	66.7	18.5	20.4	65.7	26.8	24.0	60.7	31.0	25.2	64.8	27.3	24.2
1973	59.0	20.0	18.2	63.2	26.5	22.6	66.3	39.5	30.5	63.9	28.6	23.9
1974	37.5	19.0	13.9	58.0	20.6	17.1	63.0	32.8	25.3	59.2	22.8	18.6
1975	66.7	20.0	19.2	72.7	28.4	23.5	73.7	44.3	30.6	72.9	30.9	24.6
1976	0.0	11.1	4.2	63.0	25.5	17.8	78.5	54.3	42.2	66.1	28.6	20.4
1977	60.6	30.8	27.2	69.6	39.0	28.6	77.7	56.1	45.9	70.9	40.9	30.5
1978	72.7	10.2	41.7	67.1	44.3	30.5	48.9	37.4	23.9	63.4	42.0	29.6
1979	68.6	21.7	23.3	69.7	46.1	32.4	52.0	27.9	17.6	66.4	41.8	29.4
1980	84.3	42.0	44.6	76.6	47.2	38.8	41.4	21.6	12.4	70.4	41.3	33.1
1981	46.1	21.7	15.7	78.4	46.1	39.5	47.9	19.5	14.2	71.8	37.5	31.7
1982	84.3	43.5	48.6	74.9	35.9	29.2	50.8	17.2	12.9	69.3	30.7	24.7
1983	90.9	50.0	54.5	82.9	44.4	37.8	65.5	27.6	22.2	77.5	38.5	32.2
1984	90.0	37.5	37.5	79.9	44.6	39.7	65.0	26.6	26.6	74.7	40.1	35.3
1985	75.0	25.0	33.3	66.5	39.0	33.3	55.4	30.4	27.6	62.2	36.0	31.4
							>50%					
1964	13.5	3.1	1.4	14.1	3.4	2.1	5.6	0.9	0.3	11.8	2.6	1.4
1965	0	0	0	27.3	4.4	3.2	5.4	0.7	0.3	18.3	2.9	1.6
1966	3.7	1.8	0.9	9.3	2.3	1.3	0.7	0.2	<0.1	6.2	1.6	0.8
1967	13.0	2.8	2.8	14.1	4.2	3.0	4.1	1.4	0.6	9.9	3.2	2.0
1968	26.5	9.7	11.7	15.6	3.4	2.6	3.7	1.6	0.6	12.1	3.1	2.2
1969	0	0	0	9.0	2.2	1.5	14.0	4.0	1.7	10.4	2.5	1.5
1970	0	0	0	21.5	5.9	4.2	13.6	4.4	2.6	19.6	5.6	3.9
1971	35.8	8.3	8.6	20.0	5.8	4.2	16.4	6.7	4.5	19.5	6.0	4.4
1972	38.9	7.4	6.7	23.1	6.5	5.0	15.9	6.1	4.2	21.9	6.5	5.0
1973	0	0	0	27.0	7.8	6.1	18.2	8.9	5.0	24.7	7.8	5.8
1974	0	0	0	19.2	4.8	3.3	23.2	8.2	4.2	20.1	5.3	3.5
1975	55.6	10.0	7.7	35.3	10.2	7.2	29.0	13.6	7.8	33.9	10.8	7.2
1976	0	0	0	33.3	10.0	6.0	37.0	20.7	14.8	34.1	11.1	7.0
1977	18.2	7.7	5.8	25.6	9.7	5.9	31.4	14.2	10.2	26.6	10.2	6.4
1978	45.4	2.6	12.5	26.7	13.7	7.6	8.1	6.4	3.1	23.2	12.2	6.9
1979	25.7	4.3	4.2	31.1	15.0	10.0	10.0	6.6	2.4	27.3	13.0	8.4
1980	40.0	10.0	12.2	43.0	18.2	15.3	19.4	6.4	2.9	38.7	15.3	12.5
1981	23.1	3.3	2.2	42.6	18.1	15.3	16.8	5.2	3.2	37.1	13.8	11.5
1982	25.0	4.3	8.3	41.7	14.5	12.3	24.5	5.8	3.7	37.4	11.9	9.9
1983	81.8	16.7	31.8	49.3	21.1	16.8	24.5	8.6	5.3	41.6	16.7	12.8
1984	60.0	22.2	16.7	39.2	17.6	14.5	27.0	11.1	8.0	35.0	15.4	12.3
1985	0	0	0	32.6	15.2	13.0	26.3	11.6	9.8	30.1	13.9	11.9

Table 6. USA commercial fishery (L)[1], days fished (DF), and landings per day fished (L/DF) by vessel tonnage class (Class 2: 5-50 GRT; Class 3: 51-150 GRT; Class 4: 151-500 GRT) of winter flounder for otter trawl trips catching winter flounder from Georges Bank (522-525).

	Class 2			Class 3			Class 4			Total		
Year	L	DF	L/DF	L	DF	L/DF	L	DF	L/DF	L	DF	L/DF
							All Trips					
1964	74	350	0.21	927	3101	0.30	358	2297	0.16	1359	5748	0.24
1965	68	280	0.24	886	3652	0.24	518	2782	0.19	1471	6714	0.22
1966	54	216	0.25	1166	3798	0.31	630	2766	0.23	1850	6780	0.27
1967	46	142	0.32	1073	3187	0.34	794	2268	0.35	1914	5596	0.34
1968	34	120	0.28	1039	3518	0.29	491	1521	0.32	1564	5159	0.30
1969	7	49	0.14	1541	4147	0.37	616	1404	0.44	2163	5600	0.39
1970	16	55	0.29	2002	4380	0.46	590	1142	0.52	2609	5576	0.47
1971	67	162	0.41	2281	5046	0.45	737	1351	0.54	3085	6558	0.47
1972	36	103	0.35	2232	5239	0.43	527	1118	0.47	2795	6461	0.43
1973	22	99	0.22	1725	4084	0.42	516	906	0.57	2264	5089	0.44
1974	16	72	0.22	1531	5170	0.30	568	1231	0.46	2115	6473	0.33
1975	9	52	0.17	1854	5316	0.35	544	1076	0.50	2407	6445	0.37
1976	3	24	0.12	1486	4992	0.30	386	607	0.64	1875	5624	0.33
1977	33	103	0.32	2899	5548	0.52	636	728	0.87	3568	6379	0.56
1978	11	48	0.23	2539	4496	0.56	615	798	0.77	3165	5242	0.59
1979	35	120	0.29	2434	3992	0.61	548	948	0.58	3018	5060	0.60
1980	20	148	0.47	3110	4182	0.74	705	1241	0.57	3885	5571	0.70
1981	26	134	0.19	3085	4370	0.70	823	1836	0.45	3934	6340	0.62
1982	32	72	0.44	2193	4450	0.49	693	1820	0.38	2918	6348	0.46
1983	11	22	0.50	2639	4336	0.61	1218	2408	0.50	3868	6766	0.77
1984	10	24	0.42	2549	6468	0.39	1348	3319	0.41	3908	9812	0.40
1985	4	30	0.13	1315	5396	0.24	828	2671	0.31	2148	8096	0.26
							>20%					
1964	30	28	1.07	331	226	1.46	30	10	3.00	391	264	1.48
1965	30	39	0.77	400	258	1.55	40	22	1.82	470	319	1.47
1966	18	22	0.82	532	392	1.36	55	66	0.83	605	480	1.26
1967	26	28	0.93	528	452	1.17	224	163	1.37	778	643	1.21
1968	14	26	0.54	442	373	1.18	110	89	1.24	566	488	1.16
1969	1	3	0.33	528	406	1.30	162	95	1.70	691	504	1.37
1970	2	2	1.00	1228	842	1.46	325	221	1.47	1555	1065	1.46
1971	44	32	1.38	1426	1131	1.26	389	320	1.22	1859	1483	1.25
1972	24	21	1.14	1466	1259	1.16	320	282	1.13	1810	1562	1.16
1973	13	18	0.72	1091	924	1.18	342	276	1.24	1446	1218	1.19
1974	6	10	0.60	888	884	1.00	358	311	1.15	1252	1205	1.04
1975	6	10	0.60	1348	1249	1.08	401	329	1.22	1755	1588	1.10
1976	0	0	0.00	937	888	1.06	303	256	1.18	1240	1144	1.08
1977	20	28	0.71	2017	1584	1.27	494	334	1.48	2531	1946	1.30
1978	8	20	0.40	1704	1371	1.24	301	191	1.58	2013	1582	1.27
1979	24	28	0.86	1696	1294	1.31	285	167	1.71	2005	1489	1.35
1980	59	60	0.98	2384	1622	1.47	292	154	1.90	2735	1836	1.49
1981	12	21	0.57	2420	1727	1.40	394	261	1.51	2826	2009	1.41
1982	27	35	0.77	1643	1299	1.26	352	235	1.50	2022	1569	1.29
1983	10	12	0.83	2189	1639	1.34	798	534	1.49	2997	2185	1.37
1984	9	9	1.00	2036	2568	0.79	876	883	0.99	2920	3460	0.84
1985	3	10	0.30	875	1800	0.49	459	737	0.62	1337	2547	0.52
							>50%					
1964	10	5	2.00	131	66	1.98	20	7	2.86	161	78	2.06
1965	0	0	0.00	242	98	2.47	28	8	3.50	270	106	2.55
1966	2	2	1.00	108	52	2.08	5	2	2.50	115	56	2.05
1967	6	4	1.50	151	96	1.57	33	14	2.36	190	114	1.67
1968	9	14	0.64	162	90	1.80	18	9	2.00	189	113	1.67
1969	0	0	0.00	140	61	2.30	86	24	3.58	226	85	2.66
1970	0	0	0.00	431	186	2.32	80	30	2.67	511	216	2.36
1971	24	14	1.71	457	212	2.16	121	61	1.98	602	287	2.10
1972	14	7	2.00	515	267	1.93	84	47	1.79	613	321	1.91
1973	0	0	0.00	465	251	1.85	94	45	2.09	559	296	1.89
1974	0	0	0.00	294	174	1.69	132	52	2.54	426	226	1.88
1975	5	4	1.25	654	381	1.72	158	84	1.88	817	469	1.74
1976	0	0	0.00	496	302	1.64	143	90	1.59	639	392	1.63
1977	6	6	1.00	743	328	2.26	200	74	2.70	949	408	2.32
1978	5	6	0.83	678	340	1.99	50	25	2.00	733	371	1.98
1979	9	5	1.80	759	398	1.91	55	23	2.39	823	426	1.93
1980	28	18	1.55	1337	642	2.08	137	36	3.80	1502	696	2.16
1981	6	3	2.00	1316	670	1.96	138	58	2.38	1460	731	2.00
1982	8	6	1.33	915	548	1.67	170	68	2.50	1093	622	1.76
1983	9	7	1.28	1301	730	1.78	299	128	2.36	1609	865	1.86
1984	6	4	1.50	1000	938	1.07	364	267	1.36	1370	1209	1.13

Table 7. Effects evaluated in multiplicative models of catch per unit effort. Starred levels are those used in the reference cell, 1983.

Years:	1964-1985	
Vessel tonnage class:	31	(51-72 GRT)
	32	(73-104 GRT)
	33*	(105-150 GRT)
	41	(151-215 GRT)
Depth zone	1	(1-55 m)
	2	(56-110 m)
	3*	(111-183 m)
Calendar quarters	1	
	2*	
	3	
	4	
Statistical areas	522	
	523	
	524*	
	525	

(The fraction of landings by other vessel tonnage classes and from other depth zones was very small in most years; those additional levels contained primarily empty cells and so were omitted.)

Table 8. Analysis of variance for Georges Bank winter flounder catch per unit effort, adjusted for tonnage class 33 (105-150 GRT) second quarter landings from area 524, depth zone 3 (111-183 m), trips in which 20% or more of the landings consisted of winter flounder.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Square	F
A. Model	26	731.82	28.15	74.97**
Year	21	563.32*	26.82	71.45**
Depth Zone	2	113.65*	56.82	151.36**
Tonnage Class	3	54.85	18.28	48.70*
Error	6629	2479.00	0.38	
$R^2 = 0.23$				
B. Model	26	750.21	28.85	77.43**
Year	21	563.32	26.82	71.98**
Depth Zone	2	113.65	56.82	152.49**
Area	3	23.25	24.42	65.52**
Error	6629	2460.61	0.37	
$R^2 = 0.23$				

** P>F = 0.0
* P>F = 0.0001
(as differentiated on output)

Table 9. Analysis of variance for Georges Bank winter flounder catch per unit effort, adjusted for tonnage class 33 (105-150 GRT) second quarter landings from area 524, depth zone 3 (111-183 m), trips in which 50% or more of the landings consisted of winter flounder.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares	F
A. Model	26	347.00	13.35	44.88**
Year	21	280.23	13.34	44.87**
Tonnage Class	3	46.16	15.39	51.74*
Depth Zone	2	20.61	10.30	34.66*
Error	2217	659.33	0.30	
$R^2 = 0.34$				
B. Model	27	348.15	12.87	43.41**
Year	21	280.23	13.34	44.93**
Tonnage Class	3	46.16	15.39	51.81*
Quarter	3	21.76	7.25	24.42*
Error	2216	658.18	0.30	
$R^2 = 0.34$				

** P>F = 0.0
* P>F = 0.0001
(as differentiated on output)

Table 10. Regression coefficients, standard errors of regression coefficients and relative catch per unit effort indices (e^{B_i}, where B_i = regression coefficient for year i) from ANOVA models, 20% data set.

Model	Year Depth Area			Year Depth Tonnage Class		
Year	Regression coefficient	Std. error	Relative CPUE index	Regression coefficient	Std. error	Relative CPUE
1964	0.081	0.075	1.084	0.229	0.077	1.258
1965	0.084	0.073	1.088	0.182	0.074	1.199
1966	-0.094	0.062	0.910	-0.025	0.063	0.975
1967	-0.060	0.056	0.942	-0.050	0.056	0.951
1968	0.017	0.069	1.017	0.032	0.070	1.033
1969	0.046	0.062	1.047	0.029	0.062	1.029
1970	-0.030	0.048	0.970	-0.027	0.049	0.973
1971	-0.190	0.047	0.827	-0.193	0.047	0.824
1972	-0.141	0.047	0.868	-0.131	0.047	0.877
1973	-0.058	0.049	0.944	-0.059	0.049	0.942
1974	-0.201	0.050	0.818	-0.219	0.050	0.803
1975	-0.139	0.043	0.870	-0.137	0.044	0.872
1976	-0.153	0.048	0.858	-0.131	0.048	0.877
1977	0.086	0.041	1.089	0.073	0.041	1.076
1978	0.063	0.042	1.065	0.061	0.042	1.063
1979	0.078	0.041	1.081	0.086	0.041	1.090
1980	0.216	0.040	1.241	0.243	0.040	1.275
1981	0.080	0.042	1.083	0.088	0.042	1.092
1982	0.030	0.045	1.030	0.032	0.045	1.033
1983	0.000	.	1.000	0.000	.	1.000
1984	-0.468	0.038	0.626	-0.486	0.038	0.615
1985	-0.987	0.040	0.372	-0.996	0.040	0.369

Table 11. Regression coefficients, standard errors of regression coefficients and relative catch per unit indices (e^{B_i} where B_i = regression coefficient for year i) from ANOVA models, 50% data set.

Model	Year Tonnage Class Depth			Year Tonnage Class Quarter		
Year	Regression coefficient	Std. error	Relative CPUE index	Regression coefficient	Std. error	Relative CPUE index
1964	0.104	0.117	1.109	0.149	0.117	1.160
1965	0.287	0.098	1.332	0.321	0.098	1.379
1966	-0.010	0.131	0.990	-0.005	0.131	0.995
1967	-0.038	0.099	0.963	-0.000	0.099	1.000
1968	0.091	0.111	1.096	0.051	0.111	1.052
1969	0.355	0.114	1.427	0.358	0.114	1.430
1970	0.081	0.081	1.084	0.096	0.081	1.101
1971	-0.141	0.079	0.868	-0.119	0.079	0.888
1972	0.094	0.080	1.099	0.070	0.080	1.079
1973	0.006	0.070	1.006	-0.022	0.075	0.978
1974	0.050	0.083	1.052	-0.002	0.083	0.998
1975	-0.002	0.062	0.998	-0.043	0.063	0.958
1976	-0.157	0.065	0.855	-0.161	0.065	0.851
1977	0.209	0.063	1.233	0.206	0.063	1.229
1978	0.048	0.002	1.049	0.036	0.062	1.036
1979	0.039	0.060	1.039	0.029	1.059	1.030
1980	0.276	0.055	1.317	0.266	0.055	1.305
1981	0.158	0.058	1.171	0.160	0.058	1.173
1982	0.034	0.060	1.035	0.051	0.061	1.052
1983	0.000	0	1.000	0.000	0	1.000
1984	-0.570	0.052	0.565	-0.560	0.052	0.571
1985	-1.079	0.055	0.340	-1.052	0.055	0.349

Table 12 . Composition of commercial landings from Georges Bank (statistical areas 522-525) by market category (mt, % of total; weighouts only). Ranked in order of relative fish size, peewee <small <medium ≤large mix ≤large <extra large ≤lemon.

	Unclassified		Small		Lemon		Large		Peewee		Medium		Large/Mix		Extra Large	
Year	Wt	%	Wt	%	Wt	%	Wt	%	Wt	%	Wt	%	Wt	%	Wt	%
1964	625	45.6	80	5.8	666	48.6										
1965	728	49.4	103	7.0	642	43.6										
1966	973	51.9	265	14.1	638	34.0										
1967	1174	61.3	211	11.0	531	27.7										
1968	902	58.0	172	11.0	494	31.0										
1969	1316	60.8	218	10.1	631	29.1										
1970	1453	55.6	281	10.8	879	33.6										
1971	1561	50.5	445	14.4	1083	35.1										
1972	1615	57.6	355	12.7	833	29.7										
1973			232	10.2	706	31.1	1330	58.6								
1974			224	10.5	632	29.8	1267	59.7								
1975			61	2.8	677	31.0	1446	66.2								
1976			454	24.2	441	23.5	981	52.3								
1977			892	25.0	666	18.7	2011	56.3								
1978			523	16.4	560	17.6	2100	66.0								
1979			603	19.8	670	22.0	1769	58.2								
1980	101	2.6	824	21.0	745	19.0	2257	57.4								
1981	31	0.8	902	22.6	748	18.7	2310	57.9								
1982	137	4.6	517	17.5	549	18.6	1666	56.3	33	1.1	10	0.3	47	1.6	<1	<0.1
1983	68	1.7	1506	38.7	361	9.3	1758	45.2	160	4.1	25	0.6	14	0.3	1	<0.1
1984	154	3.9	1230	31.3	369	9.4	2077	51.6	108	2.8	27	0.7	4	0.1	6	0.2
1985	76	3.5	573	26.7	264	12.3	1076	50.0	110	5.1	46	2.1	2	0.1	3	0.1

Table 13. Stratified mean catch per tow of winter flounder from NEFC research vessel surveys, Georges Bank (Strata 13-22). KG/Tow. No catches were made in Strata 14 or 15.

MEAN CATCH/TOW, KG

	Stratum 13	16	17	18	19	20	21	22	Total Stratified Mean	Std. Dev.	C.V.
FALL											
65	.971	1.357			2.460	3.440	0.280		1.475	.514	34.9
66		1.114			4.317	25.840	1.440		4.068	1.386	34.1
67	1.813	.175			.656	8.567			1.492	.590	39.5
68					2.622	1.883			.771	.200	25.9
69	.811	1.733			2.167	5.75			1.716	.594	34.6
70	.457	.512			7.300	25.700	1.800	0.450	4.649	2.652	56.8
71		.336			1.711	3.867	0.800		.906	.362	40.0
72		.792			.700	7.050	0.450		1.137	.332	29.2
73	.100	.736			1.167	2.883	2.175		.860	.329	38.3
74	.400	.308			2.378	2.433	2.950		1.053	.510	48.5
75	.256	2.400			.767	4.683	3.400		1.483	.563	38.0
76		2.160			4.600	11.280		1.067	2.824	1.154	40.9
77	.200	5.365			3.445	5.814	1.200		2.872	.682	24.1
78	1.028	2.720		.280	1.756	7.436	3.000		2.230	.455	20.4
79	.428	1.790			6.328	6.550	3.112		2.755	.748	27.1
80	.011	2.000			.900	4.267	4.229		1.342	.441	32.9
81	.389	.740			2.244	9.167			1.751	.462	26.4
82		.380			1.044	14.783	.450		1.937	.451	23.3
83	.522	1.400			.733	8.883	2.825		1.700	.699	41.1
84	.011	.170			3.467	8.450	1.325		1.759	.801	45.6
85	.811	.940			3.328	0.000			1.119	.412	36.8
SPRING											
68		1.856			7.138	1.750	.450		2.240	1.240	55.4
69	.300	3.693			6.237	6.333	.450		3.086	.654	21.2
70		0.500			4.363	5.160	.450		1.650	.417	25.3
71	.756	0.042			3.978	4.900			1.560	.414	26.6
72		7.677			5.600	5.517			3.828	1.307	34.1
73	.056	7.030			1.478	3.167			2.523	.922	39.3
74	1.700	5.350			7.767	5.683		2.500	4.160	1.439	34.6
75	.511	.180			3.344	1.233			1.012	.625	61.7
76	.011	3.400			3.633	4.450			2.167	.613	28.3
77		.411			5.889	1.483		.400	1.560	.615	39.4
78	.922	5.675			6.389	5.067	.525		3.637	1.348	37.1
79		1.260			2.128	2.483			1.587	.446	28.1
80		.850			4.078	8.417			2.015	.809	40.2
81	.033	1.770			8.133	3.900			2.697	1.054	39.4
82		.620	.325		4.056	.383	.075		1.096	.407	37.1
83		6.540			6.811	17.750	.150		5.116	1.966	38.4
84	1.833	.800			10.300	11.183			4.032	1.061	26.3
85		.530			9.411	4.367			2.650	1.042	39.3
86	.488	.600			2.811	4.317			1.335	.427	32.0

MEAN CATCH/TOW, NUMBER

	Stratum 13	16	17	18	19	20	21	22	Total Stratified Mean	Std. Dev.	C.V.
FALL											
65	1.143	.714			3.400	2.800	.200		1.474	.681	46.2
66		.714			4.833	21.200	.400		3.536	1.434	40.6
67	1.750	.125			.667	6.333			1.227	.558	45.5
68					3.556	1.167			.896	.291	32.5
69	.444	1.750			3.111	3.667			1.623	.574	35.3
70	.429	.250			7.000	19.833	.750	.250	3.849	2.186	56.8
71		.545			2.111	2.667	.500		.907	.390	43.0
72		.583			.667	5.167	.250		.864	.247	28.6
73	.111	.545			1.222	2.167	4.500		.834	.297	35.6
74	.444	.333			1.889	1.667	1.250		.817	.371	45.4
75	.111	2.000			.889	16.500	2.000		2.596	1.455	56.0
76		3.000			8.889	12.600		.667	4.101	1.508	36.8
77	.300	4.941			5.273	7.429	.625		3.330	.890	26.7
78	1.000	2.467		.200	4.389	8.429	1.500		2.778	.554	19.9
79	.444	1.450			8.833	9.500	1.500		3.469	.930	26.8
80	.111	1.500			1.111	3.500	2.714		1.138	.335	29.5
81	.444	.900			5.333	10.556			2.624	.931	35.5
82		.300			2.333	28.167	.250		3.631	.756	20.8
83	.667	1.667			1.000	9.333	1.750		1.867	.668	35.8
84	.111	.100			4.778	14.667	.750		2.694	.126	46.7
85	1.333	.900			6.750				1.979	.701	35.4
SPRING											
68		.889			6.50	1.833	.250		1.849	1.010	54.6
69	.444	2.500			3.750	5.333	.250		2.148	.456	21.2
70		.400			3.375	4.000	.250		1.277	.288	22.6
71	.444	.083			3.667	3.167	.200		1.259	.261	20.8
72		6.231			5.333	5.500			3.388	1.218	35.9
73	.222	5.300			1.333	2.667			2.018	.740	36.7
74	1.750	4.600			8.889	5.000			4.143	1.564	37.7
75	1.333	.600			3.000	2.333			1.339	.522	39.0
76	.111	2.600			6.778	9.500			3.200	.909	28.4
77		.778			11.556	2.500		.250	2.980	1.158	38.8
78	1.222	6.833			10.000	5.667	2.50		4.841	1.756	36.3
79		2.200			1.778	2.082			1.189	.320	26.9
80		.700			3.444	11.833			2.206	1.062	48.2
81	.111	1.800			7.111	4.333	.250		2.553	1.011	39.6
82		.900	.250		5.667	.833	.250		1.572	.478	30.4
83		7.500			6.222	22.500	.250		5.757	2.196	38.1
84	1.444	.545			10.111	10.667			3.787	1.035	27.3
85		.500			14.778	4.667			3.837	1.671	43.6
86	1.125	1.300			5.556	4.000			2.213	.775	35.0

Table 14. Correlations between research vessel survey indices and commercial catch per unit effort indices from fishing power analysis.

	CPUE Index							
			20% Trips				50% Trips	
	Yr/Depth/Area		Year/Depth/Tonclass		Yr/tonclass/depth		Yr/tonclass/Qtr	
	B_i	e^{Bi}	B_i	e^{Bi}	B_i	e^{Bi}	B_i	e^{Bi}
Full strata set (13-22)								
Fall								
Kg/tow/normal	.192	.233		.187		.128		.113
#/tow, recruited	.075	.071						
Kg/tow, delta	.211	.144		.212		.099		.128
Spring								
Kg/tow, normal	-.179	-.207						
#/tow, recruited	-.222	-.207						
Kg/tow, delta	.210	-.233						
Reduced strata set (16, 19-21)								
Fall								
Kg/tow, normal		.151		.137				
Kg/tow, delta		.175		.156				
Kg/tow, retransformed		.171		.189				
Single stratum								
Fall								
13, Kg/tow, normal	-.083	-.180	-.057	-.036	-.031	-.028	-.004	.066
16, Kg/tow, normal	.239	.283	.209	.212	.222	.191	.220	.259
kg/tow, delta		.285		.191				
kg/tow, transformed	.114	.251	.181	.178				
19, Kg/tow, normal	-.060	-.051	-.020	.006	-.116	-.122	-.101	.096
20, Kg/tow, normal	.153	.094	.160	.079	.112	.034	.128	.057
kg/tow, delta	.178	.121	.163					
kg/tow, transformed	.404	.330	.412	.312	.319	.201	.245	.217
21, Kg/tow, normal	.279	.279	.262	.251	.194	.144	.107	.053
kg/tow, delta		.326		.240				
kg/tow, transformed		.198		.161				
Spring								
13, Kg/tow, normal		-.277						
16, Kg/tow, normal	.169	.145	.171	.109				
kg/tow, delta		.084						
19, Kg/tow, normal		-.465						
20, Kg/tow		.010						

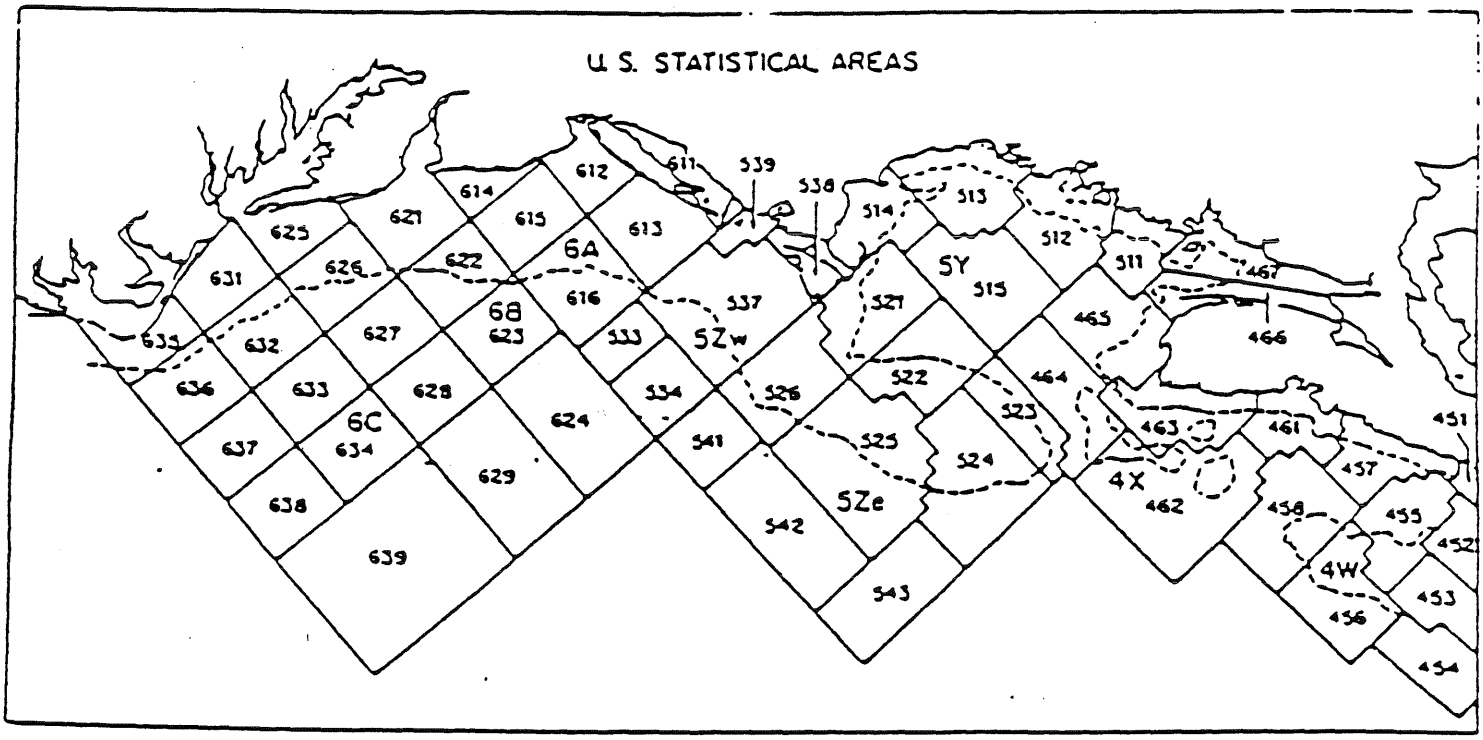


Figure 1. Statistical areas used for reporting USA commercial fishery statistics. Georges Bank stock area is defined as statistical areas 522-525.

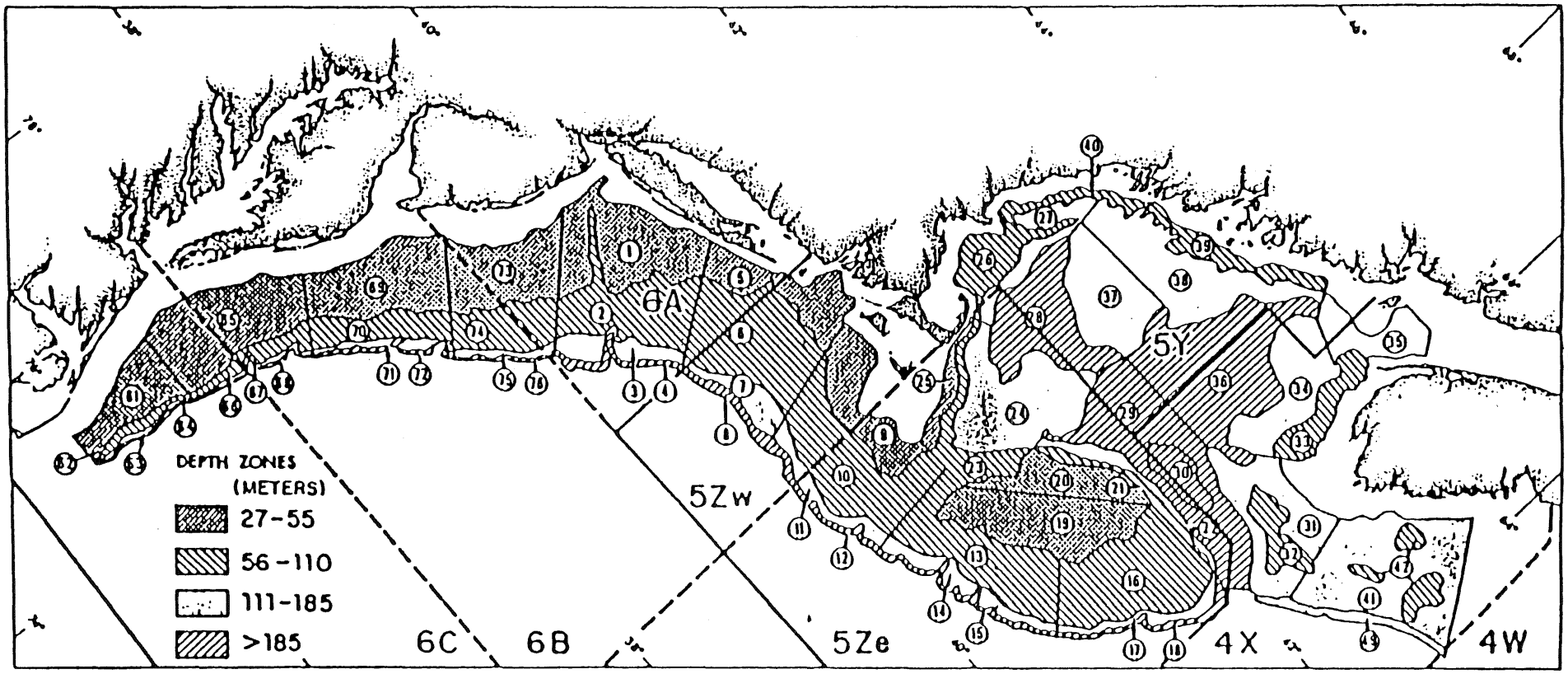


Figure 2 . Sampling strata used in NEFC spring, summer and autumn bottom trawl surveys. Georges Bank stock area is defined as survey strata 13-22.

Figure 3. Commercial nominal catch of winter flounder from areas (NAFO divisions) including Georges Bank, 1962-1985.

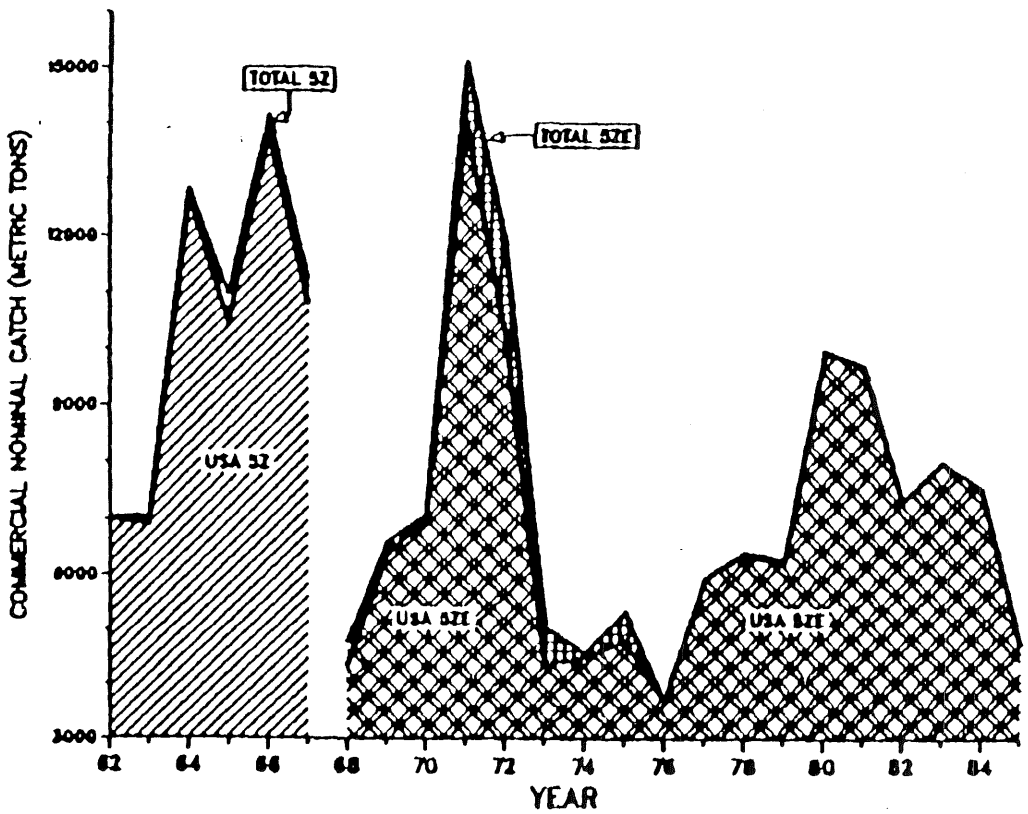


Figure 4. Commercial nominal catch of winter flounder from statistical areas 522-525, Georges Bank, 1962-1985.

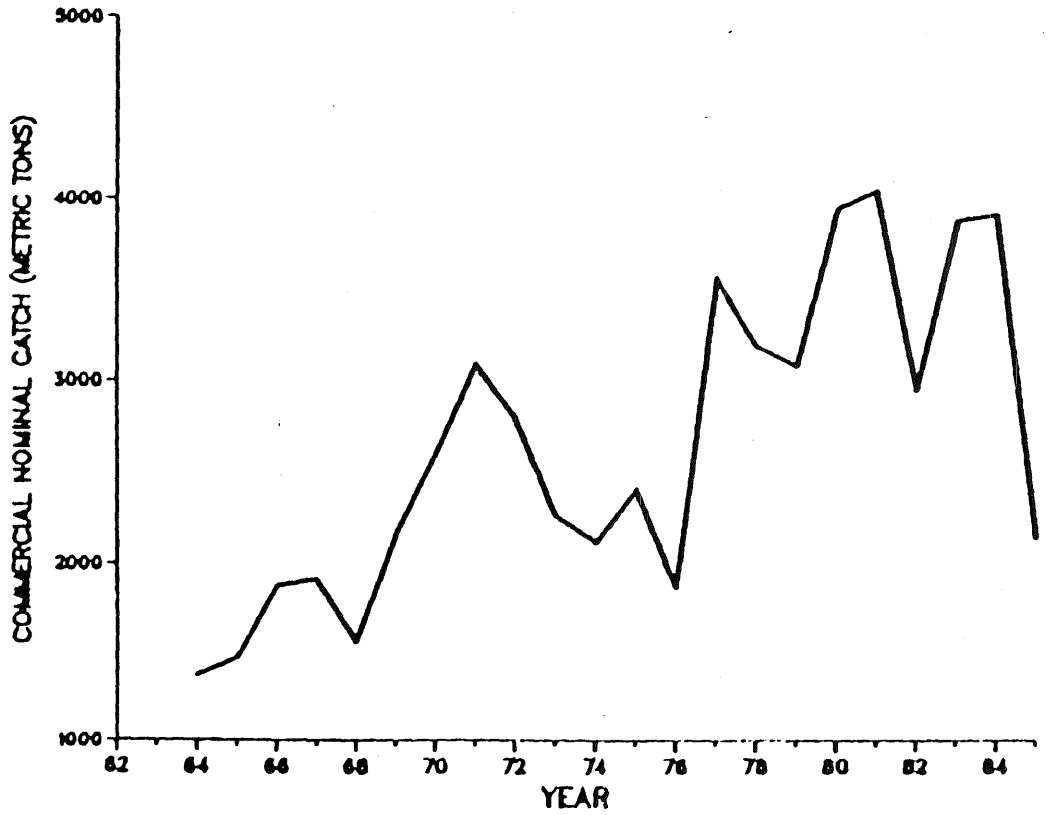


Figure 5. Indices of relative catch per unit effort based on ANOVA of trips where landings of winter flounder exceeded 20% of total landings.
Top: Year depth area model.
Bottom: Year depth tonnage class model.

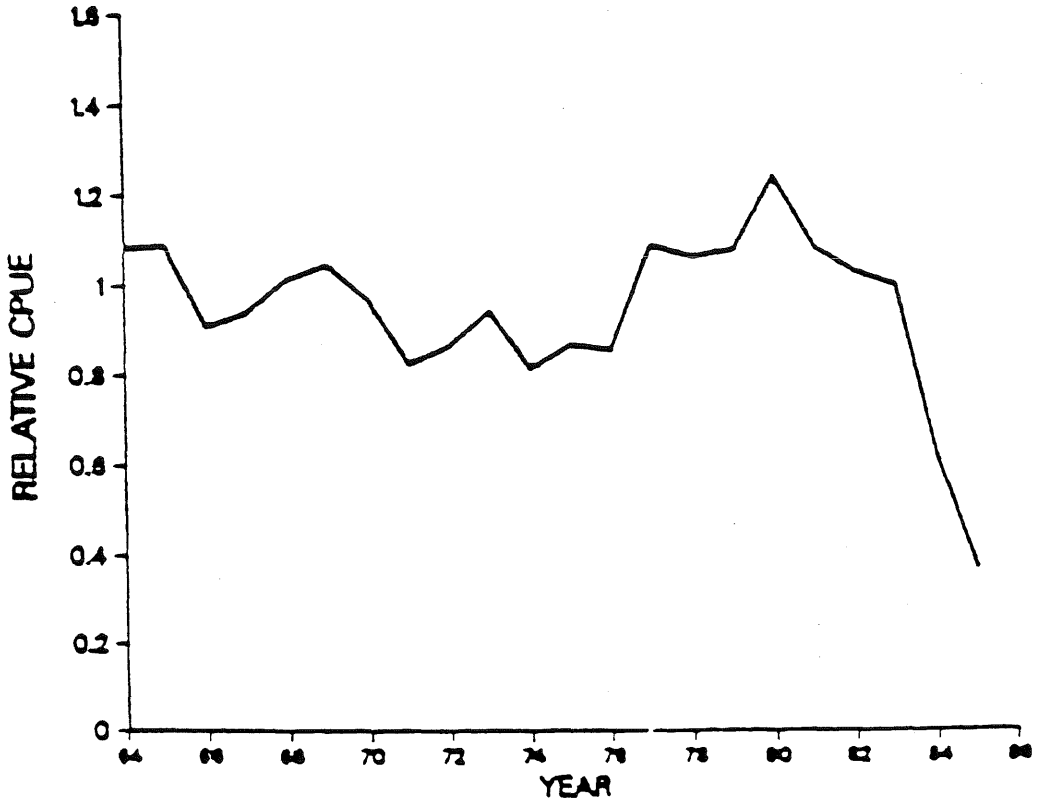
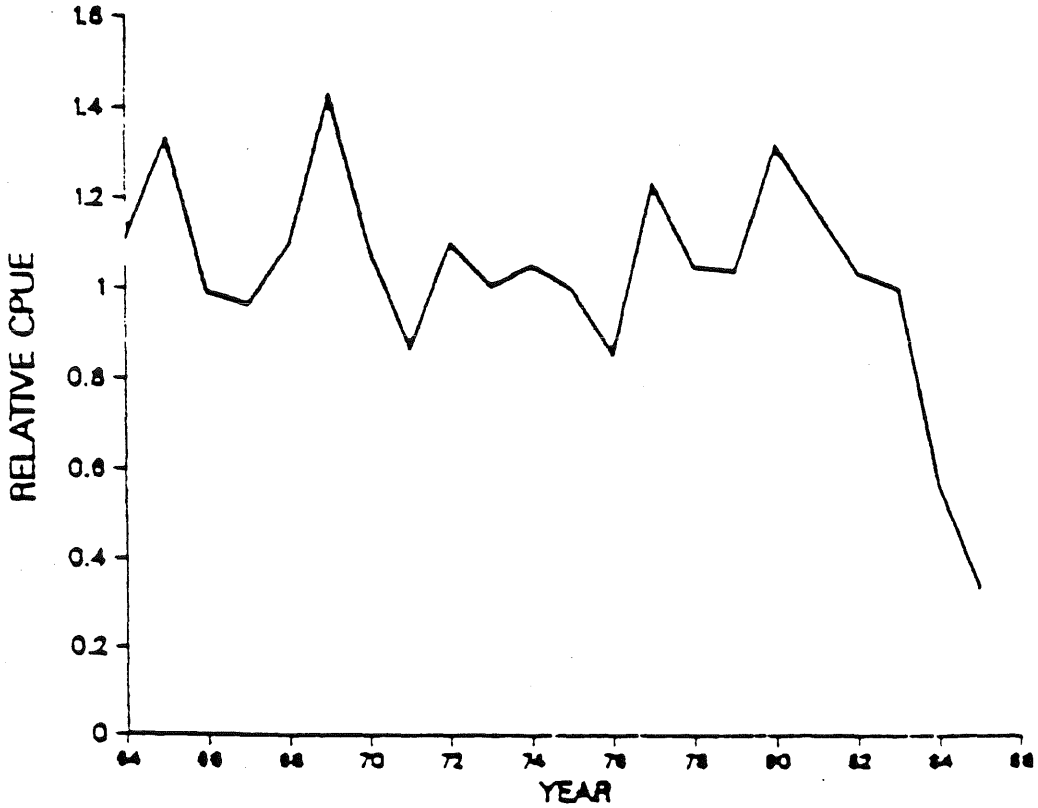
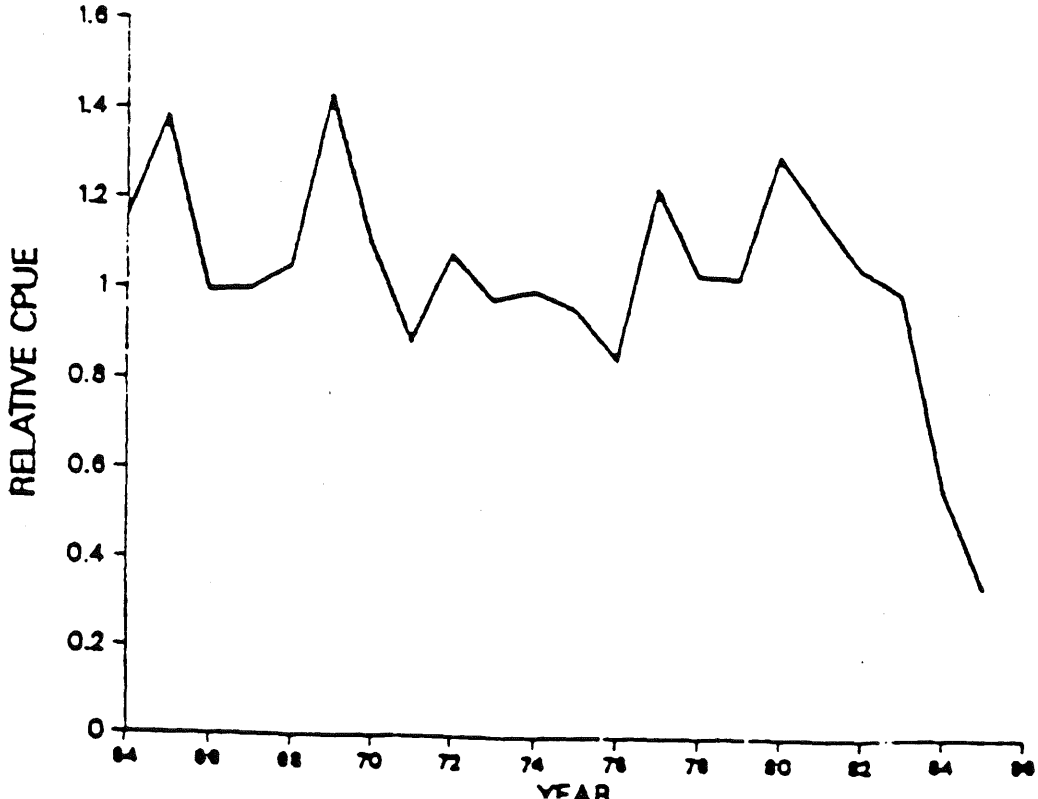


Figure 6. Indices of relative catch per unit effort based on ANOVA of trips where landings of winter flounder exceeded 50% of total landings.
Top: Year tonnage class depth model.
Bottom: Year tonnage class quarter model.





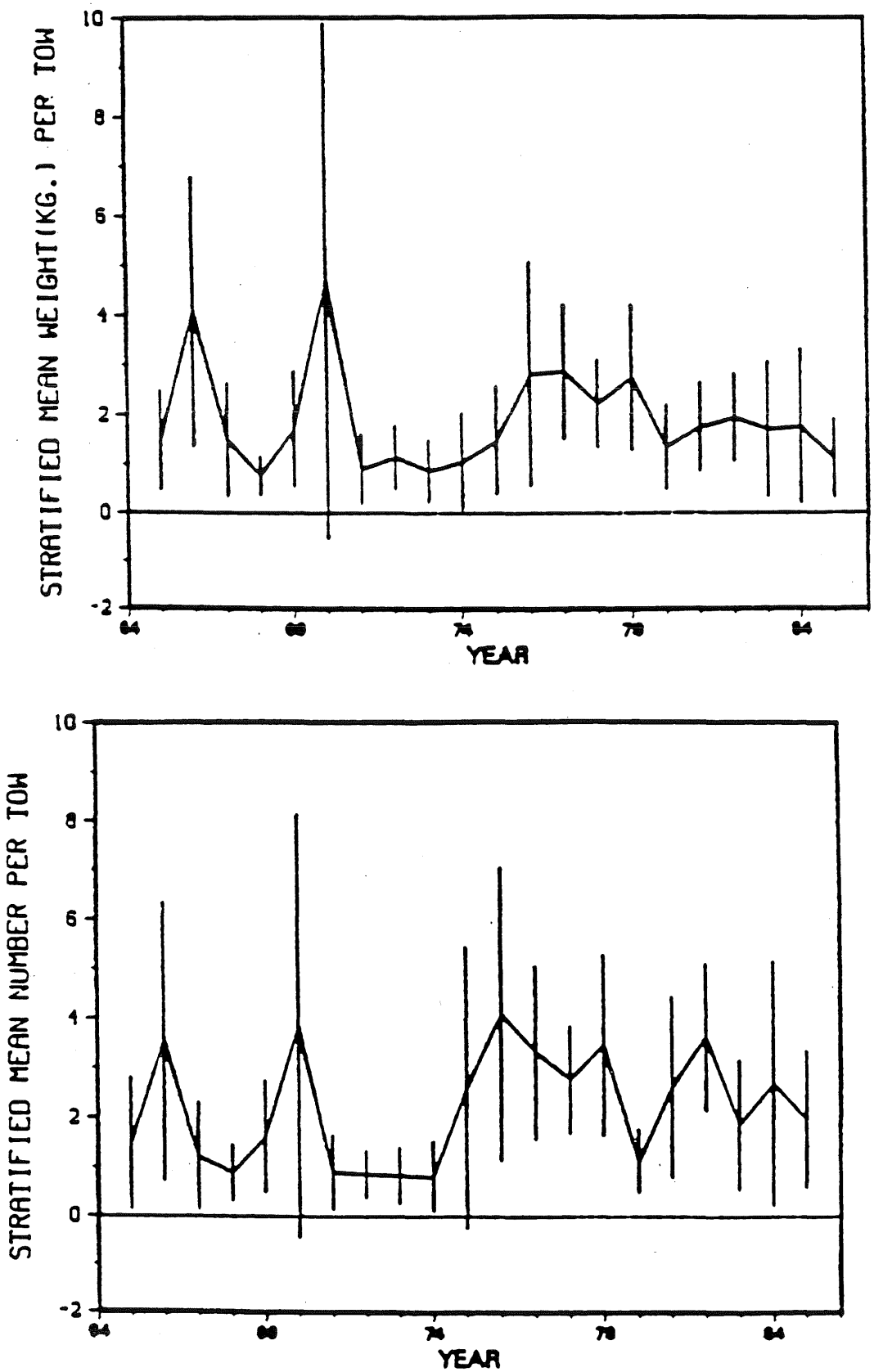


Figure 7. Stratified mean catch/tow of winter flounder from autumn NEFC research vessel surveys, Georges Bank (strata 13-22).

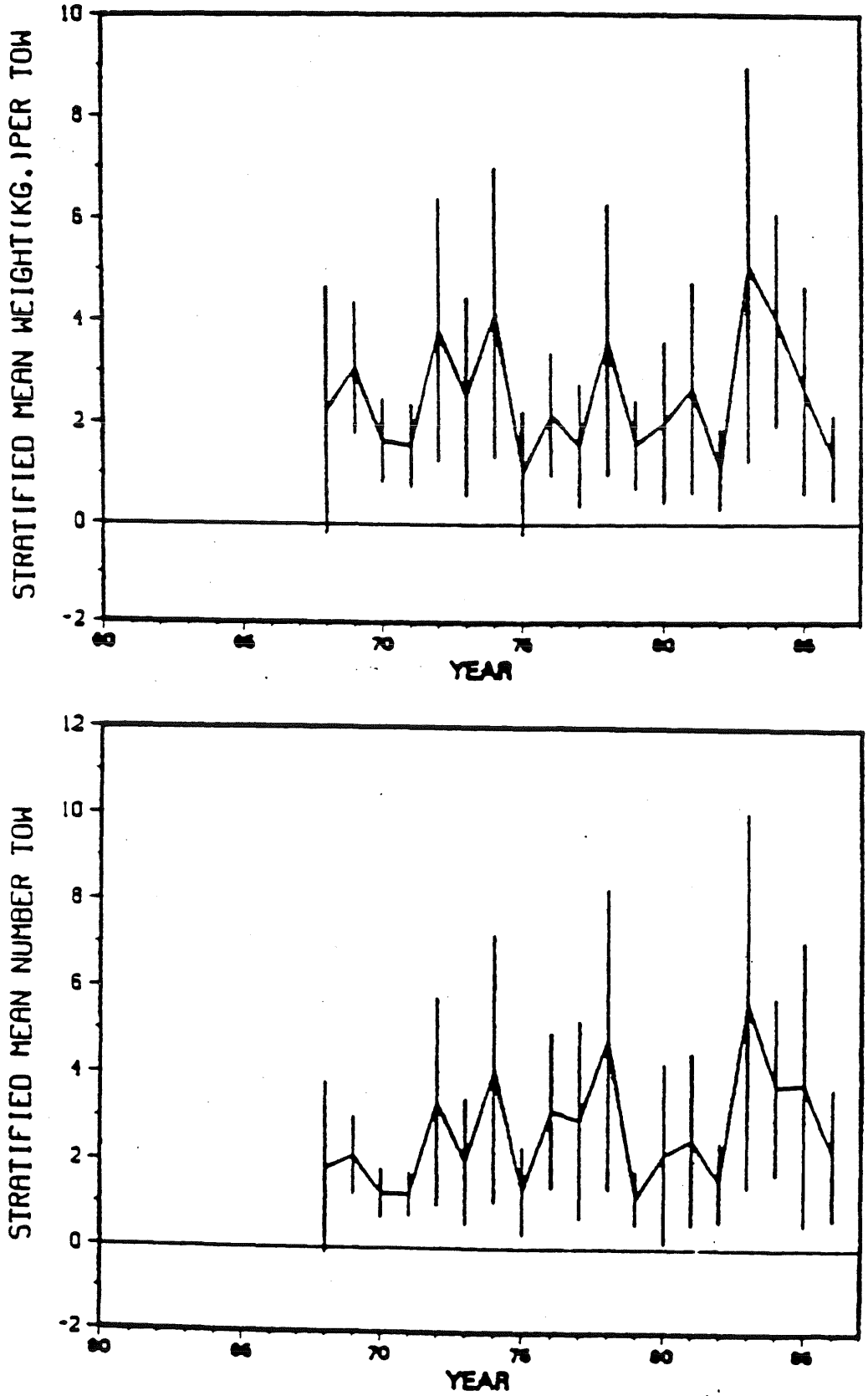
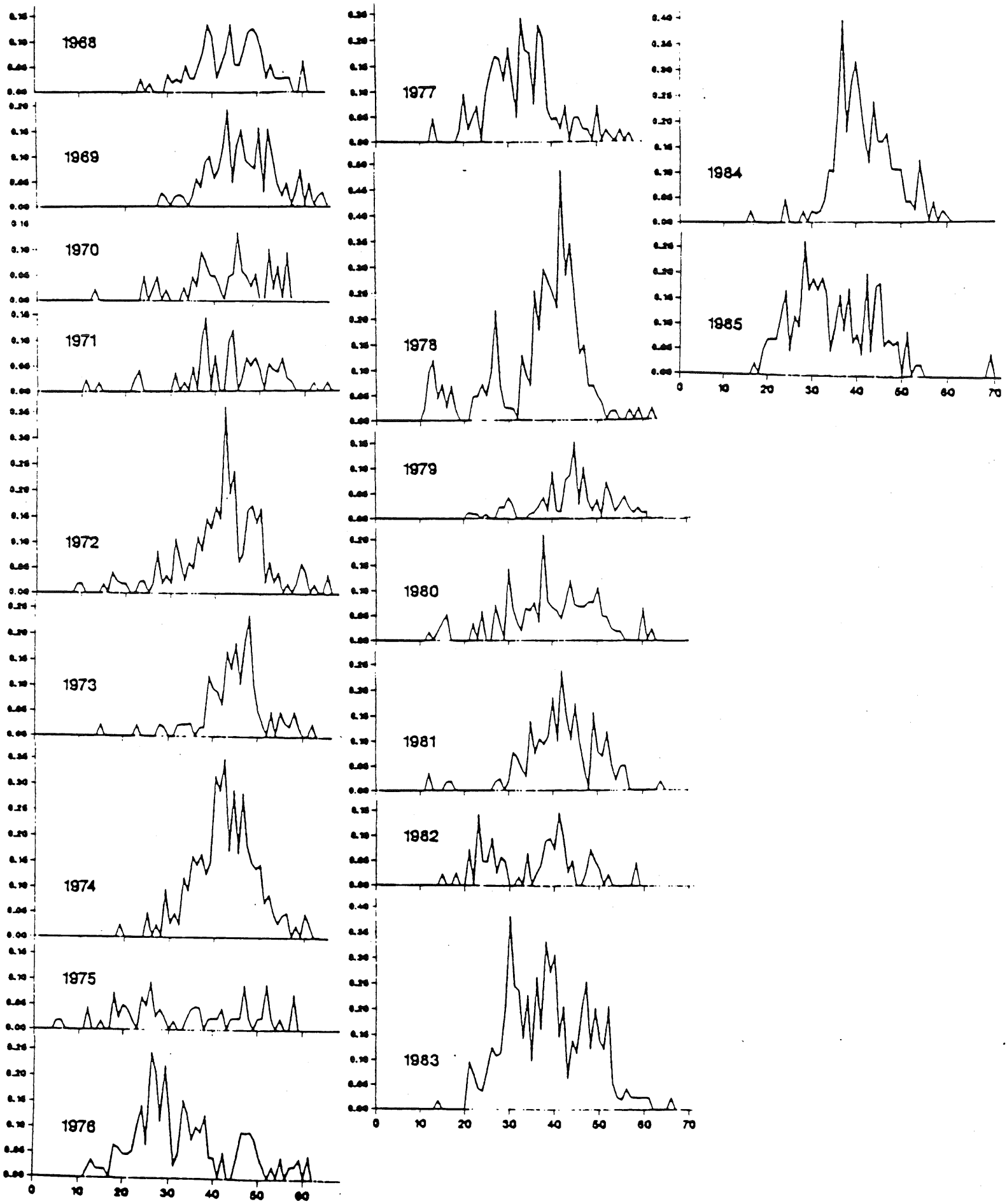


Figure 8. Stratified mean catch/tow of winter flounder from spring NEFC research vessel surveys, Georges Bank

FIG. 9 STRATIFIED MEAN NUMBER/TOW OF GEORGES BANK WINTER flounder (STRATA 13-22) 1968-1985



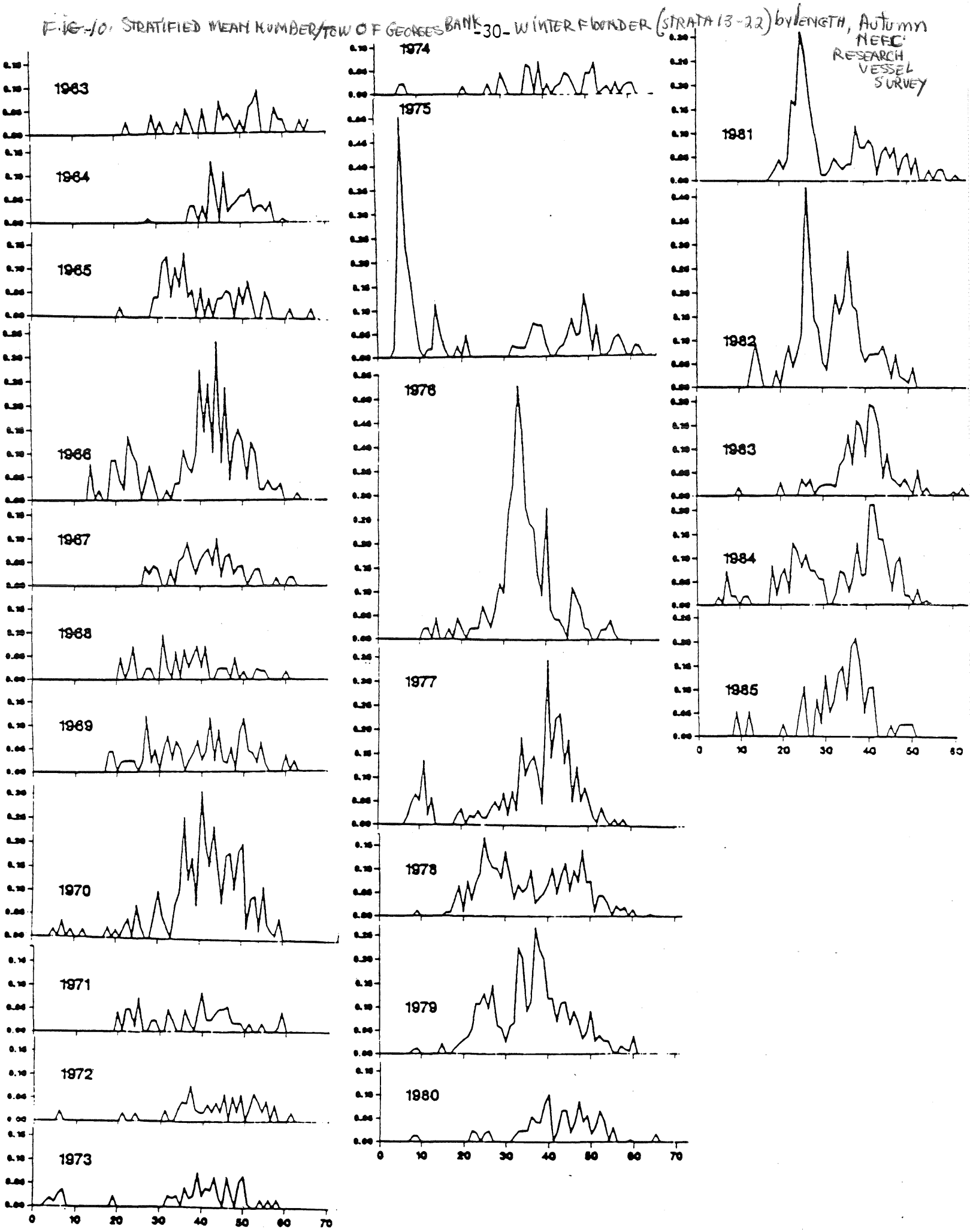


Figure 10. Stratified mean number/tow of Georges Bank winter flounder (strata 13-22) by length, Autumn NEFC Research Vessel Survey

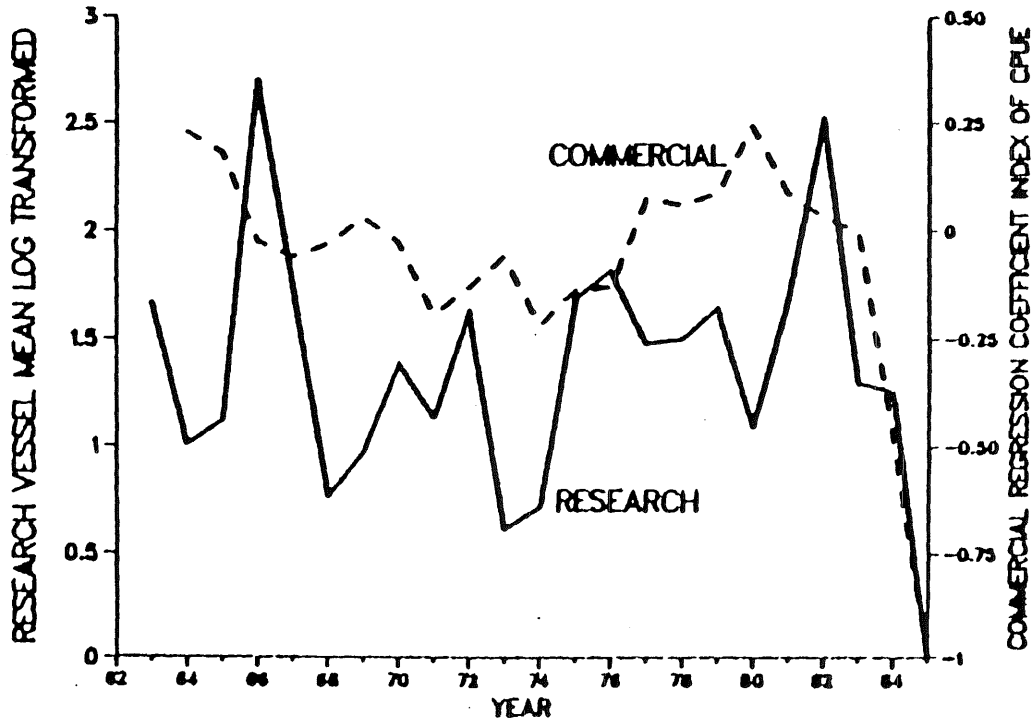



Figure 11. Trends in log transformed catch/tow (kg), stratum 20, NEFC research vessel survey and regression coefficient index of CPUE, 20% trips, year/depth/tonnage class model.