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The 1985 assessment of 5Ze haddock

by

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Abstract

The annual catches of haddock from NAFO Subdivision 5Ze have declined since 1965, when peak landings of 150,362 t were recorded. During the period 1935-1960, the average annual landings of haddock was 46,000 t. The declining trend since 1965 is attributed to either poor year-classes or recruitment overexploitation of strong year-classes. After a moderate increase in landings between 1976 and 1980, catches have once more shown a decline.

The 1984 landings were about 14% lower than in 1983 and the lowest since 1976. Canadian landings in 1984 were less than half of the 1983 catch and accounted for only 14% of the total landings. Canadian otter trawl catches in 1984 fell, for the first time, below those of longliners. The 1978, 1980 and 1975 year-classes accounted for about 41, 13 and 16%, respectively, of the catch (by weight).

Indicators of stock size (number and biomass caught) calculated from US surveys continue to indicate declining abundance since 1979. The RV recruitment index suggests that the 1984 year-class is very small while the 1983 year-class may be about 25% of the 1978 year-class. June to September CPUE indices for Canadian TC 4 and 5 stern trawlers are about the same level as in the early to mid-1970's.

A sequential population analysis was conducted for the period 1963-1984, assuming $M = 0.20$ and with fully-recruited F 's (0.50) determined by examination of the relationship between \ln age 3+ population numbers in year $_{t+1}$ (from cohort analysis) vs \ln age 2+ in year $_t$ (from the research surveys). Fishing mortality for the fully recruited ages was greater than the $F_{0.1}$ of 0.26 in recent years and the 2+ population numbers suggest the lowest population level since 1972. At the current levels of exploitation, the stock is believed to be in a state of growth overfishing and may be dangerously close to reproductive overfishing.

Résumé

Les prises annuelles d'aiglefin de la subdivision 5Ze de l'OPANO ont décliné depuis 1965, année où des débarquements records de 150 362 t ont été enregistrés. De 1935 à 1960, les débarquements annuels moyens d'aiglefin ont été de 46 000 t. La tendance à la baisse depuis 1965 est attribuée soit à des classes d'âge faibles, soit à une surexploitation du recrutement des classes d'âge fortes. Après une augmentation moyenne des débarquements entre 1976 et 1980, les prises ont décliné de nouveau.

Les débarquements de 1984 ont été de 14 % environ inférieurs à ceux de 1983, soit les plus faibles depuis 1976. Les débarquements canadiens de 1984 ont été inférieurs à la moitié de ceux de 1983 et ne représentaient que 14 % des débarquements totaux. Les prises canadiennes au chalut à panneaux de 1984 ont été, pour la première fois, inférieures à celles des palangriers. Les classes d'âge de 1978, 1980 et 1975 représentaient environ 41, 13 et 16 % des prises (en poids) respectivement.

Les indicateurs de la taille des stocks (nombre et biomasse capturés), calculés d'après des recensements américains, continuent d'indiquer une chute d'abondance depuis 1979. L'indice de recrutement de NR révèle que la classe d'âge de 1984 est très petite, tandis que celle de 1983 serait égale à 25 % environ de celle de 1978. Les indices de PUE de juin à septembre pour les chalutiers arrières canadiens de CT 4 et 5 sont à peu près les mêmes que ceux de la première moitié des années 1970.

Une analyse séquentielle des populations a été effectuée pour la période 1963-1984, en supposant que $M = 0,20$ et que les F de recrutement complet (0,50) ont été déterminés à partir de la relation entre \ln de la population d'âge 3+ pendant l'année $t+1$ (d'après l'analyse des cohortes) et \ln de la population d'âge 2+ pendant l'année t (d'après les recensements). La mortalité par pêche dans les âges de recrutement complet a été supérieure au $F_{0,1}$ de 0,26 au cours des dernières années et la population d'âge 2+ serait la plus faible depuis 1972. Au rythme actuel d'exploitation, le stock serait surpêché au niveau du taux de croissance et pourrait l'être à un niveau voisin du taux de reproduction.

Introduction

Total landings of the Georges Bank haddock fishery have fluctuated greatly since the fishery evolved in the 1920's. The highest level of exploitation (150,000 t) occurred during the mid 1960's. The long-term sustainable yield has been estimated to be about 50,000 t (Overholtz et al. 1983). Historically, the fishery has been dominated by one or two year-classes. The capacity to overexploit the stock probably developed in the late 1920's and the problem of massive discarding of undersized haddock has occurred in the 1930's (Herrington 1936), 1950's (Graham and Premetz 1955), and late 1970's (Overholtz et al. 1983). Previous stock assessment (Overholtz et al. 1983; O'Boyle MS 1983; Waiwood and Neilson MS 1984) have indicated a continued decline in stock abundance, with recruitment in recent years well below the long-term average.

Patterns of Exploitation

The total annual catches for Georges Bank haddock are presented in Fig. 1. A high rate of exploitation of Georges Bank haddock by European and Soviet fleets began in the early 1960's. Canadian and US effort also increased and an all time record of 150,362 t was landed in 1965 (Fig. 2), Table 1). The USSR alone accounted for over 54% of the total landings (81,882 t). These catches were not sustained for long and within 5 years, the landings had fallen to less than one-tenth the 1965 level. The problem was compounded by poor recruitment in the mid to late 1960's.

Since 1963, Canadian landings of 5Z haddock have averaged about 24% of the total landings. The highest proportion (% of total landings) was observed in 1978 (46%). In 1984, however, Canadian landings comprised only 14% (1463 t) of the total. The 1984 landings, the lowest since 1976, are less than half of the 1983 landings of 3213 t, which comprised 27% of total landings of 5Z haddock.

Catches by the Canadian fleet are given by month in Table 2. The largest fraction of total annual landings are usually taken in June and July. In contrast with the US pattern of exploitation, relatively small catches have been taken during the January-February period in recent years (1983-1984). However, from 1977-1982, the February landings did comprise a relatively large fraction of total landings.

The majority of the Canadian catch has been taken by Nova Scotian trawlers, mainly Tonnage Class (TC) 4 side and TC 4 and 5 stern trawlers (Tables 3 & 4, Figs. 3 & 4). Since 1978, the relative contribution of the TC 4 side trawlers has declined with no landings reported in 1983 and 1984. While TC 5 stern trawlers have usually taken the largest fraction of the stern trawl catch, TC 2 and 3 catches were greater than the TC 5 catch in 1984. Longliner catches have been relatively low up to 1979 but have increased recently and in 1984, exceeded total landings attributed to otter trawlers (Table 3, Fig. 3). The Canadian patterns of exploitation contrast with those of the US, as the US longliner component was comparatively small or absent in recent years and no TC 5 vessels were present.

During the recent history of the 5Z haddock fishery (1956-present), the US annual landings were greatest in 1965 when 52,823 t were caught. Landings subsequently declined until 1974, when only 2396 t were caught. Catches have increased since then, with 19,176 t removed in 1981. However, since 1981, catches have once again declined with only 8806 t caught in 1984 (Table 1, Fig. 2). The 1984 landings are 2% higher than those reported in 1983 (8668 t). A detailed discussion of the history of the 5Z haddock fishery, including management measures, is given in Waiwood and Neilson (MS 1984).

Catches by the US fleet are summarized by month in Table 5. The largest fraction of total landings are usually taken in May, June and July. The seasonal pattern of exploitation has not varied much from year to year, with the exception of recent years (1980-present), when relatively large catches have been made during the January-February period (Fig. 5). The bulk of US landings are taken by otter trawlers (Table 6, Fig. 6) of TC 3 and 4 (Table 7, Fig. 7), a pattern which has persisted since 1968.

Age Composition of Landings

Sampling of Canadian and US catches

Summaries of US and Canadian sampling by gear by quarter are presented in Tables 8 and 9. Canadian sampling in 1984 was the poorest since 1974, representing only 3 longline trips.

Canadian and US catch at age calculated from their corresponding domestic sampling have differed noticeably in most years (Waiwood and Neilson MS 1984). Generally, large year-classes in US catch-at-age data are often assigned to two adjacent year-classes (ages 2 and 3) in the Canadian catch at age with the apparent strength of the older year-class not evident in subsequent years. To determine if true differences in age composition occur between the US and Canada catches, length frequencies for Canadian otter trawl catches (third quarter) were compared to corresponding values for US landings. Unfortunately, the number of years for comparison is small and the analysis is less than conclusive. By comparison with the US catch, the Canadian otter trawl catch had relatively smaller fish in 1980 and relatively larger fish in 1982. There was little difference in length composition in 1981 (Fig. 8). This preliminary analysis does not support the argument that apparent differences in age composition of the catch (based on Canadian ageing) in 1980 were due to real differences in size composition (see Waiwood and Neilson MS 1984). With the higher percentage of older fish (age 3) in the Canadian landings, one would have expected relatively more (not less) larger fish when compared with the US catch. These results support the view that calculation of the Canadian catch at age should not be based on Canadian age data although it may be possible to use Canadian length frequency and US length-at-age data for this purpose.

Construction of the catch-at-age matrix

Following O'Boyle (MS 1983) and Waiwood and Neilson (MS 1984), the catch at age reported in Overholtz et al. (1983) was used for the years 1963

to 1980. Details of how these values were calculated and how adjustments were made for discarding of the 1972, 1975 and 1978 year-classes are given in the above reports. Since 1977, the total catch at age was estimated by summing the corresponding US and Canadian values. The latter were estimated by assuming that the Canadian catch composition was identical to that of the US and adjusting for the weight of the Canadian catch. The values were determined on a quarterly basis and summed over quarters to obtain yearly totals. The removals at age for 1981-1983 were re-calculated in this manner to reflect corrected and additional US data. Since, in 1984, over half the Canadian catch was taken by the longline fishery and the US catch was predominantly taken by otter trawls, the above method was deemed inappropriate. Accordingly, the longline catch at age was calculated from Canadian length frequencies and US length-at-age keys. A length weight equation ($a = 0.0000158$, $b = 2.91612$), derived from data collected by port samplers ($n = 245$) was used to calculate sample weights. Only the Canadian otter trawl catch was estimated by pro-rating with the US catch (Table 10). United States catch-at-age values for the fourth quarter were not available. Hence, third quarter values (adjusted for catch) were used.

The composition of the catch in numbers, percent by numbers and percent by weight is given in Tables 11 to 13. Historically, the 52e haddock fishery has been dominated by 1 or 2 strong year-classes. The 1962 and 1963 year-classes largely supported the fishery from 1965 to 1972. More recently, the catch has been predominated by the 1975 and 1978 year-classes. In 1984, the 1978 and 1980 year-classes accounted for 41 and 13%, respectively, of the catch (by weight) with 9+ fish (mostly 1975 year-class) accounting for 16%. Beginning of year and annual average weights at age are given in Tables 14 and 15.

The length frequency for June and July 1985 OTB catches (Canadian) are given in Fig. 9. Assuming a mean length at age 2 of about 44 cm, it would appear that the 1983 year-class is well represented in the 1985 catch.

Stock Abundance Trends

Research vessel surveys

Autumn and spring trawl surveys on Georges Bank and in the Gulf of Maine have been conducted by NMFS since 1963 and 1968, respectively. Summer surveys have been run sporadically since 1963, but were discontinued in 1981. All surveys were of the stratified random design (Fig. 10) and used a Yankee 36 trawl except for the spring surveys which, for the period 1973-81, used a modified Yankee 41 trawl.

Trends in numbers and biomass of haddock caught in the spring and fall surveys are indicated in Fig. 11 and Tables 16 and 17. For numbers caught per tow, the two surveys indicate an increase in abundance during the mid to late 1970's and a decline since then to 1968-1974 levels. The biomass caught per tow shows a similar trend, but the pattern is displaced to the right reflecting the relative contribution of the large 1975 and 1978 year-classes (Fig. 11).

An RV recruitment index was calculated by normalizing the 1963 to 1983 (0 group) and 1964 to 1984 (age 1) numbers per tow to their respective averages and then averaging across ages for each cohort (Table 18). In order of decreasing rank, the top 5 year-classes from 1963 to 1984 were 1963, 1975, 1978, 1980 and 1972. The index for the 1984 year-class (based on 0 group only) is the lowest in the time series.

Commercial catch rates

June to September CPUE indices for Canadian TC 4 and 5 stern trawlers are presented in Fig. 12 and Table 19. The landings with effort and the total hours fished for 1984 are low reflecting the low total catches for these gears. The percentages of the catch with appropriate effort data for 1984 were 16.1 and 19.0, respectively, for TC 5 and TC 4. Considering the 1984 values were represented by only 24 tons (104 hours) for TC 5, the index for 1984 should be interpreted and applied with caution. Since 1973, with the possible exception of 1981 and 1982, the two series are in good agreement indicating an increase in catch rates over the period 1973 to 1979 followed by a decrease in recent years. There has been a particularly steep decline in catch rate for TC 5 stern trawlers from 1983 to 1984.

Estimation of mortality and population size

Analysis of total mortality for fully recruited ages using the US fall and spring survey data indicate that Z values increased during 1981-1982 and have declined in 1983 and 1984 (Table 17). F's on fully recruited ages were 0.382 and 0.512 for spring and fall surveys, respectively, assuming $M = 0.2$.

Two relationships were considered in determining F values for fully recruited ages:

1. $\ln 3+$ numbers from cohort analysis vs $\ln 2+$ numbers per tow from the US fall survey,
2. \ln average fishable biomass vs \ln TC 5 stern trawlers CPUE (3rd quarter).

Both relationships were constrained by a slope of 1. Cohort analysis was performed using Pope's (1972) cohort formula (modified from Rivard 1982). Natural mortality was assumed to be 0.2. Mortalities for ages 8 and 9+ were recalculated as the arithmetic average of the age 4 to 8 values when the 1984 F's were changed. The sum of residuals squared was used as the calibration criterion. A summary of the cohort analysis is given in Tables 20 and 21 and Figs. 13 and 14. For the fall survey calibration relationship, the lowest sum of squares for residuals was derived from input terminal F's of 0.50. The pattern in sum of squares for residuals was different with the relationship \ln fishable biomass vs \ln TC 5 CPUE (constrained by a slope of 1) in that lower sums were observed at lower levels of input F's ($F < 0.3$). This was due mainly to the influence of the 1982 and 1983 points which appeared to be abnormally high when compared to the fall survey and the CPUE

for TC 4 stern trawlers. The relationship with input F's of 0.5 is indicated in Fig. 14. Two relationships were examined to estimate the 1983 year-class (age 2) in 1985: the ln Fall RV ages 0 and 1 numbers per tow vs ln cohort 1 and 2 numbers, respectively (lagged one year). These relationships are displayed in Figs. 15 and 16. Years with zero values in the RV survey index were excluded and both relationships were constrained to a slope of one. From the former relationship, a value of 9541 was predicted from the 1984 fall survey. From the latter relationship, a value of 23,942 was obtained assuming an instantaneous total mortality on age 1 (1984) of 0.2. The average 16,742 was used as an estimated of age 2 fish in 1985.

Estimates of numbers at age 1 in 1984 were obtained from the above relationship between ln Fall RV numbers per tow and ln cohort numbers (lagged one year) and from the equation $N_{t+1} = N_t e^{-Zt}$ where $N_{t+1} = 9541$ and $Z = 0.20$ (Table 22). The average (20,448) of these two estimates was used to represent the numbers at age 1 in 1984. Using the previous survey relationship to estimate numbers at age 1 for 1985 gave a predicted value lower than any in the series, hence the lowest value (385) in the series was used to represent this year-class.

The final cohort analysis is displayed in Table 23. Considering the beginning of year estimate of population size in 1985 we conclude that the beginning of year population biomass in 1985 will be about 27,700 t, lower than in 1984 (37,000 t), and about the same as the all time low in 1973. The relative and absolute contribution of the strong 1975 and 1978 year-classes to the 1985 fishery will be lower than in 1984. Fishing mortality is well above the $F_{0.1}$ level and there is little optimism that the stock can recover to historical levels of productivity under this high level of exploitation. A significant reduction in fishing pressure is required to produce a gradual rebuilding of the spawning stock size. Catches in 1985 and 1986 will probably be dictated by the size and availability of the 1983 year-class which at first approximation as about one quarter the size of the 1978 year-class.

These results are in agreement with a recent analysis by Gabriel et al. (1984) which suggests that current levels of spawning stock biomass per recruit are inadequate to maintain this stock nor to allow for rebuilding. Similarly, Overholtz and Clark (in preparation) constructed a stochastic simulation model, based on recruitment and parent stock data, to examine the long-term effects of fishing on recovery of the spawning biomass. Given the current stock size and continued exploitation at $F = 0.4$ to 0.5 , they concluded the following:

- (1) spawning biomass will not recover within 20 years to a level corresponding to a rebuilt stock (3+ biomass of 70,000 t);
- (2) long-term average simulated yields of 11,000 to 15,000 t will be expected;
- (3) the range of recruitment will be low (between 0 and 80 million fish);

(4) there were few management options for rebuilding the stock.

At $F = 0.1$, they concluded the following:

- (1) there is a high probability that spawning stock biomass will recover within 15 years reaching levels in excess of 70,000 t,
- (2) production of an above-average year-class will greatly accelerate this recovery;
- (3) although yields will initially be smaller, they will soon surpass those identified with the previous option,
- (4) the frequency and magnitude of a good year-class will increase and the range of recruitment will be greater (0 to 340 million fish).

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Table 1. Nominal catches (t) of haddock from Georges Bank¹ for 1956-1984². (---- no fishing activity, - no TAC).

Year	USA (%)	Canada ⁵ (%)	USSR (%)	Spain (%)	Others ³ (%)	Total	TAC ICNAF	TAC Canada	TAC US
1956	51144 (100)	----	----	----	----	51144	-		
1957	48561 (100)	----	----	----	----	48561	-		
1958	37322 (100)	----	----	----	----	37322	-		
1959	36051 (100)	----	----	----	----	36051	-		
1960	40800 (100)	77 (<1)	----	----	----	40877	-		
1961	46384 (99)	266 (1)	----	----	----	46650	-		
1962	49409 (91)	3461 (6)	1134 (2)	----	----	54004	-		
1963	44150 (80)	8379 (15)	2317 (4)	----	----	54846	-		
1964	46512 (73)	11625 (18)	5483 (9)	2 (<1)	464 (1)	64086	-		
1965	52823 (35)	14889 (10)	81882 (54)	10 (<1)	758 (<1)	150362	-		
1966	52918 (44)	18292 (15)	48409 (40)	1111 (1)	544 (<1)	121274	-		
1967	34728 (67)	13040 (25)	2316 (5)	1355 (3)	30 (<1)	51469	-		
1968	25469 (62)	9292 (23)	1397 (3)	3014 (7)	1720 (4)	40892	-		
1969	16456 (74)	3990 (18)	65 (<1)	1201 (5)	540 (2)	22252	-		
1970	8415 (74)	1978 (18)	103 (1)	782 (7)	22 (<1)	11300	12000		
1971	7306 (67)	1630 (15)	374 (3)	1310 (12)	242 (2)	10862	12000		
1972	3869 (67)	609 (11)	137 (2)	1098 (19)	20 (<1)	5733	6000		
1973	2777 (52)	1563 (29)	602 (11)	386 (7)	3 (<1)	5331	6000		
1974	2396 (56)	462 (11)	109 (3)	764 (18)	559 (13)	4290 ⁶	-		
1975	3989 (74)	1358 (25)	8 (<1)	61 (1)	4 (<1)	5420	6000		
1976	2904 (67)	1354 (31)	4 (<1)	46 (1)	9 (<1)	4317 ⁷	6000		
1977	7934 (73)	2909 (27)	----	----	----	10843 ⁸	-	12600	10500
1978	12160 (54)	10179 (46)	----	----	----	22339 ⁸	-	12600	19000 ¹⁰
1979	14279 (73)	5182 (27)	----	----	----	19461 ⁹	-	39000	22100 ¹⁰
1980	17470 (63)	10101 (37)	----	----	----	27571 ⁹	-	32500	22900 ¹⁰
1981	19176 (77)	5659 (23)	----	----	3 (<1)	24835	-	32500	22900 ¹⁰
1982	12567 (72)	4931 (28)	----	----	----	17498	-	32500	-
1983	8669 (73)	3212 ⁴ (27)	----	----	----	11881	-	28000	-
1984	8806 (86)	1463 ⁴ (14)	----	----	----	10269	-	20000	-

¹Includes NAFO Areas 5Ze, 5Zw, and 5Nk.

²Data Sources ICNAF (1956-1978, NAFO (1979-1983).

³Bulgaria, Cuba, Federal Republic of Germany, France, German Democratic Republic, Ireland, Japan, Poland, Romania, and United Kingdom.

⁴Provisional (incomplete).

⁵Landings in the Maritimes, Quebec and Newfoundland.

⁶⁻⁹Corresponding values corrected for discards are: ⁶6190, ⁷20531, ⁸26281, ⁹51084.

¹⁰Does not represent calendar year and does not always include Canadian allocation. Values for 1977 and 1978 are for Subarea 5. Values for 1979-81 include recreational fishery.

Table 2. Monthly and quarterly breakdown of Canadian catch of 5Ze haddock from 1968 to 1985.

Year	Month												Quarter				Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1	2	3	4	
1968	337	510	990	2337	760	352	693	1240	910	904	120	139	1837	3449	2843	1163	9292
1969	106	73	6	291	587	691	559	607	553	364	119	34	185	1569	1719	517	3990
1970	10	105	0	1	576	345	104	456	241	103	25	12	115	922	801	140	1978
1971	0	9	2	0	400	153	283	279	97	246	140	21	11	553	659	407	1630
1972	0	118	2	0	4	112	87	116	91	70	9	0	120	116	294	79	609
1973	4	10	0	0	0	183	198	569	339	233	23	4	14	183	1106	260	1563
1974	19	0	1	0	0	57	64	52	96	60	93	20	20	57	212	173	462
1975	5	14	0	0	0	167	257	482	104	167	117	45	19	167	843	329	1358
1976	0	8	61	68	61	588	152	188	186	26	9	7	69	717	526	42	1354
1977	102	176	6	0	23	519	1098	836	12	58	56	23	284	542	1946	137	2909
1978	103	932	44	21	22	319	407	86	640	5605	2000	0	1079	362	1133	7605	10179
1979	125	898	398	175	69	1393	905	395	488	261	53	22	1421	1637	1788	336	5182
1980	39	134	13	33	225	2957	2299	963	1419	1739	103	177	186	3215	4681	2019	10101
1981	38	482	568	4	254	1354	1242	727	292	82	378	238	1088	1612	2261	698	5659
1982	131	309	1	12	45	1118	767	684	582	838	400	44	441	1175	2033	1282	4931
1983 ¹	31	67	28	46	60	1288	386	489	527	194	90	6	126	1394	1402	290	3212
1984 ¹	3	5	80	87	73	434	218	256	212	70	25	0	88	594	686	95	1463
1985 ¹	1	11	39	107	25	321	228										

¹Provisional data.

Table 3. Nominal catches (t)¹ of haddock caught by Canadian (Maritimes and Quebec) fishing vessels on Georges Bank (NAFO Subdivision 5Ze) during 1968-1984. Numbers in parentheses indicate number of samples taken by DFO personnel.

Year	Gear			Total
	Otter trawlers	Longliners	Other	
1968	9170(8)	111	11	9292
1969	3955(2)	22	13	3990
1970	1900(5)	76	2	1978
1971	1475(1)	154	1	1630
1972	411	198	0	609
1973	1461(3)	102	0	1563
1974	374(5)	87	1	462
1975	1247(1)	111	0	1358
1976	1185(9)	154	15	1354
1977	2814(11)	94	1	2909
1978	9716(27)	171	292	10179
1979	4907(17)	274	1	5182
1980	9510(25)	590	1	10101
1981 ²	4644(17)	1015(2)	0	5659
1982 ^{2,3}	4212(17)	719	0	4931
1983 ^{2,3}	2396(8)	813	3	3212
1984 ^{2,3}	625	835(3)	3	1463

¹Excludes catches by tonnage class one vessels except for 1983 longliners (27 tons).

²Maritimes only.

³Provisional.

Table 4. Nominal catches (t) of haddock caught by Canadian (Maritimes) otter trawlers on Georges Bank (NAFO Subdivision 5Ze) during 1968-1984. (See Fig. 5).

Year	Side Otter Trawlers T.C.				Stern Otter Trawlers T.C.				Total Otter Trawlers
	2	3	4	5	2	3	4	5	
1968	0	176	3463	0	1165	0	580	3786	9170
1969	1	8	792	0	0	1	225	2928	3955
1970	0	25	553	0	2	0	134	1186	1900
1971	0	0	494	0	0	0	16	965	1475
1972	0	0	0	0	0	0	148	263	411
1973	0	25	609	0	0	0	61	766	1461
1974	0	0	26	0	0	6	8	334	374
1975	0	0	223	0	0	1	60	963	1247
1976	0	1	192	23	0	0	61	908	1185
1977	5	47	358	0	91	243	18	2052	2814
1978	69	17	2485	0	238	822	351	5734	9716
1979	12	116	1573	0	135	855	651	1565	4907
1980	9	16	1426	1	354	365	1016	6323	9510
1981	4	87	389	0	448	484	884	2348	4644
1982	1	25	90	0	190	297	250	3359	4212
1983	16	89	0	0	618	432	107	1134	2396
1984	0	5	0	0	180	270	21	149	625

Table 5. Monthly and quarterly breakdown of U.S. catch of 5Ze haddock from 1968 to 1984. Yearly totals may not agree exactly with Table 1 and 5.

Year	Month												Quarter				Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1	2	3	4	
1968	1680	1756	3025	2383	2470	2747	2695	2260	2371	1972	1376	704	6461	7600	7326	4052	25439
1969	991	909	1617	2423	1687	2328	1357	1466	1394	1121	630	538	3517	6438	4217	2289	16461
1970	480	418	409	635	1232	1327	1088	818	748	800	246	208	1307	3194	2654	1254	8409
1971	306	477	641	719	1147	1075	670	546	555	542	400	229	1424	2941	1771	1171	7307
1972	246	309	274	282	632	562	384	369	236	266	161	159	829	1476	989	586	3880
1973	177	165	137	180	340	539	329	270	135	254	132	130	479	1059	734	516	2788
1974	191	131	139	214	299	329	351	199	124	155	97	177	461	842	674	429	2406
1975	239	203	143	235	573	852	320	350	360	296	235	179	585	1660	1030	710	3985
1976	189	228	224	277	532	348	132	169	222	169	240	164	641	1157	523	573	2894
1977	238	373	363	380	747	905	1018	828	574	777	958	746	974	2032	2420	2481	7907
1978	533	736	674	976	1315	2063	1251	1289	974	1140	914	249	1943	4354	3514	2303	12114
1979	758	640	777	1357	1847	1747	1552	1486	1169	1082	1282	527	2176	4951	4207	2891	14224
1980	1016	1395	1132	1701	2322	1581	2054	1543	1772	980	1049	845	3543	5604	5369	2874	17390
1981	1193	2305	1372	1521	2586	2502	1915	1591	1272	1008	773	751	4870	6609	4778	2532	18789
1982	828	1164	752	774	1417	2415	1623	697	1049	709	728	454	2744	4606	3369	1891	12610
1983	885	1076	390	758	864	1676	737	592	513	341	486	361	2351	3298	1842	1188	8679
1984	832	1157	583	599	1105	1570	735	747	523	412	271	271	2572	3274	2005	954	8805

Table 6. U.S. catches of 5Z haddock by gear type, 1968-1984¹.

Year	Otter Trawl	Line Trawl	Other	Total
1968	24,924	495	21	25,440
1969	15,486	962	14	16,462
1970	7,977	430	2	8,409
1971	7,002	305	2	7,309
1972	3,674	201	6	3,881
1973	2,673	112	3	2,788
1974	2,308	97	2	2,407
1975	3,838	143	4	3,985
1976	2,838	51	5	2,894
1977	7,839	36	32	7,907
1978	11,960	63	90	12,113
1979	14,130	30	65	14,225
1980	17,167	30	194	17,391
1981	18,662	3	126	18,791
1982	12,468	1	140	12,609
1983	8,586	35	58	8,679
1984	8,658	57	89	8,804

¹Note that these values (obtained from U.S. NMFS) may not agree exactly with data appearing in Table 1.

Table 7. U.S. otter trawl catches of 5Z haddock by tonnage class, 1968-1984¹.

Year	TC 2	TC 3	TC 4	Total
1968	464	13,628	10,832	24,924
1969	143	8,246	7,097	15,486
1970	61	4,699	3,217	7,977
1971	54	4,335	2,613	7,002
1972	23	2,483	1,168	3,674
1973	21	1,596	1,056	2,673
1974	71	1,432	805	2,308
1975	88	2,534	1,216	3,838
1976	78	1,927	833	2,838
1977	249	5,765	1,825	7,839
1978	180	8,763	3,017	11,960
1979	187	9,632	4,311	14,130
1980	265	9,720	7,182	17,167
1981	266	9,881	8,515	18,662
1982	153	6,343	5,972	12,468
1983	72	3,573	4,941	8,586
1984	68	4,129	4,461	8,658

¹Note that these values (obtained from U.S. NMFS) may not agree exactly with data appearing in Table 1.

Table 8. U.S. sampling of 5Z haddock by gear and quarter (1973-1978) and by year (1979-1984).

Year	Gear	Quarter	Length Samples		Age Samples	
			No.	No. sampled	No.	No. aged
1973	OTB	1	14	1392	14	287
		2	21	2132	21	428
		3	13	933	11	295
		4	13	1290	9	200
1974	OTB	1	9	761	4	145
		2	16	1285	14	307
		3	11	923	11	240
		4	17	1307	16	310
1975	OTB	1	21	1594	22	423
		2	19	1728	20	556
		3	10	878	10	177
1976	OTB	1	13	965	13	275
		2	15	1214	15	283
		3	3	157	3	76
		4	1	103	1	26
1977	OTB	1	18	1432	18	383
		2	28	2390	28	517
		3	55	3849	55	901
		4	42	2857	42	698
1978	OTB	1	34	2490	33	576
		2	49	4726	49	867
		3	41	3051	41	702
		4	15	1132	15	277
1979		All	112		124	
1980		All	121		118	
1981		All	66		66	
1982		All	101		98	
1983		All	103		101	
1984		All	59		47	

Table 9. Canadian Sampling of 5Z haddock by gear and quarter.

Year	Gear	Quarter	Length Samples		Age Samples	
			No.	No. sampled	No.	No. aged
1973	OTB	3	2	589	2	72
		4	1	432	1	38
1974	OTB	3	1	220	1	29
		4	4	834	4	114
1975	OTB	3	3	1034	3	91
		4	2	471	2	72
1976	OTB	2	4	927	4	146
		3	3	617	3	110
		4	1	205	1	30
1977	OTB	1	1	236	1	40
		2	1	217	1	36
		3	8	1609	8	239
		4	2	416	0	0
1978	OTB	1	10	2246	10	320
		3	1	200	1	19
		4	16	6205	11	255
1979	OTB	1	3	2081	3	99
		2	9	1964	9	233
		3	5	1046	5	133
1980	OTB	1	1	214	1	26
		2	3	818	3	106
		3	17	4378	17	421
		4	4	965	4	131
1981	OTB	1	2	508	2	62
		2	6	1327	6	189
		3	7	1517	7	191
		4	1	232	1	34
	LL	3	1	207	1	29
		4	1	230	1	27
1982	OTB	2	2	369	2	49
		3	6	1198	6	163
		4	9	1880	9	288
1983	OTB	2	4	1093	3	97
		3	4	903	4	121
1984	LL	3	1	242	1	29
		4	2	468	2	55

Table 10. US, Canadian otter trawl, and Canadian longline catches in 1984 by quarters (000's).

Age	Quarter				Total
	1	2	3	4 ¹	
A. US Catch (All Gears)					
2	0	41	25	12	78
3	43	120	92	44	299
4	120	212	204	98	634
5	138	138	40	19	338
6	473	395	314	149	1331
7	52	117	0	0	169
8	62	116	79	37	294
9+	120	188	48	23	379
B. Canadian Otter Trawl and Other					
2	0	4	3	0	7
3	0	12	10	0	22
4	1	21	23	1	45
5	1	13	5	0	19
6	3	39	35	0	77
7	1	11	0	0	12
8	1	11	9	0	21
9+	1	18	5	0	24
C. Canadian longliners					
2	0	0	0	0	0
3	0	3	6	1	10
4	2	9	25	5	41
5	3	8	5	1	17
6	11	29	73	16	129
7	2	8	0	0	10
8	2	9	18	4	33
9+	4	10	10	2	26
D. TOTAL					
2	0	45	28	12	85
3	43	135	107	46	331
4	123	242	252	103	720
5	145	159	50	20	374
6	487	463	422	165	1537
7	55	136	0	0	191
8	65	136	106	41	348
9+	125	216	63	25	429

¹Preliminary - based on 3rd quarter catch at age.

Table 11. Estimated age composition (numbers in 000's) of haddock in landings (all countries) from Georges Bank (NAFO Subdivision 52e) during 1963-1984. Numbers in brackets have been corrected for discarding (see text).

Age	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	2910	10101	9601	114	1150	8	2	46	1	156	2560	46	192	144	0	0	0	8	0	78	0	0
2	4047	15935	125818	6843	168	2994	11	158	1375	2	2057	(4320)	1034	473	(19585)	761	26	(31000)	1661	1424	87	85
3	7418	4554	44496	100810	2891	709	1698	16	223	450	3	657	1864	550	187	(14395)	1726	347	9550	1634	748	331
4	11152	4776	5356	19167	20667	1921	448	570	40	81	386	2	375	880	680	305	7169	975	754	2895	709	720
5	8198	8722	4391	2768	10338	14519	654	186	289	32	53	70	4	216	515	567	525	6054	699	335	1923	374
6	2205	5794	6690	2591	1209	3499	5954	214	246	120	30	2	42	1	357	517	410	594	2278	645	267	1537
7	1405	2082	3772	2332	993	677	1574	2308	285	78	77	2	4	23	4	139	315	546	308	1387	222	191
8	721	1028	1094	1268	917	453	225	746	1469	66	15	53	4	4	39	14	96	153	139	130	875	348
9+	1096	1332	1366	867	698	842	570	464	928	1236	447	249	88	112	111	67	46	81	80	119	96	429
TOTAL	39152	54324	202584	136760	39031	25622	11136	4708	4855	2221	5628	(5401)	3607	2403	(21479)	(16766)	10314	(39758)	15469	8648	4928	4015
Nominal																						
Catch	54846	64086	150362	121274	51469	40923	22252	11300	10862	5733	5331	(6190)	5420	4324	(20531)	(26281)	19461	(51084)	24835	17498	11881	10269
(t)																						
Catch ¹																						
wt.	57731	67823	181774	140715	52065	41018	22336	12376	11998	6464	6790	7295	5545	4304	25980	27023	21100	43424	24857	17531	11988	9977
(t)																						
Ratio	0.95	0.94	0.83	0.86	0.99	1.00	1.00	0.91	0.91	0.89	0.79	0.85	0.98	1.01	0.79	0.97	0.92	1.18	1.00	1.00	0.99	1.03

¹Obtained by multiplying numbers caught at age by corresponding mean weight-at-age data in Table 14.

Table 12. Estimated age composition (percent numbers) of haddock in total landings from Georges Bank (NAFO Subdivision 5Ze) during 1963-1984. Values have been adjusted to reflect estimates of discards.

AGE	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	7.43	18.59	4.74	0.08	2.95	0.03	0.02	0.98	0.02	7.02	45.49	0.85	5.32	5.99	0.00	0.01	0.01	0.02	0.00	0.90	0.00	0.00
2	10.34	29.33	62.11	5.00	0.43	11.69	0.10	3.36	28.32	0.09	36.55	79.99	28.67	19.68	91.18	4.54	0.25	77.97	10.74	16.47	1.77	2.12
3	18.95	8.38	21.96	73.71	7.41	2.77	15.25	0.34	4.59	20.26	0.05	12.16	51.68	22.89	0.87	85.86	16.73	0.87	61.74	18.90	15.88	8.24
4	28.48	8.79	2.64	14.02	52.95	7.50	4.02	12.11	0.82	3.65	6.86	0.04	10.40	36.62	3.17	1.82	69.51	2.45	4.87	33.48	14.39	17.93
5	20.94	16.06	2.17	2.02	26.49	56.67	5.87	3.95	5.95	1.44	0.94	1.30	0.11	8.99	2.40	3.38	5.09	15.23	4.52	3.88	39.03	9.32
6	5.63	10.67	3.30	-1.89	3.10	13.66	53.47	4.55	5.07	5.40	0.53	0.04	1.16	0.04	1.66	3.08	3.98	1.49	14.73	7.46	5.42	38.28
7	3.59	3.83	1.86	1.71	2.54	2.64	14.13	49.02	5.87	3.51	1.37	0.04	0.11	0.96	0.02	0.83	3.05	1.37	1.99	16.04	4.50	4.76
8	1.84	1.89	0.54	0.93	2.35	1.77	2.02	15.85	30.25	2.97	0.27	0.98	0.11	0.17	0.18	0.08	0.93	0.38	0.90	1.51	17.76	8.67
9+	2.80	2.45	0.67	0.63	1.79	3.29	5.12	9.86	19.11	55.65	7.94	4.61	2.44	4.66	0.52	0.40	0.45	0.20	0.52	1.37	1.94	10.68

Table 13. Estimated age composition (percent weight) of haddock in total landings from Georges Bank (NAFO Subdivision 5Ze) during 1963-1984. Values have been adjusted to reflect estimates of discards.

AGE	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	2.87	7.45	3.06	0.05	1.46	0.01	0.00	0.26	0.01	1.50	22.62	0.45	2.15	2.01	0.00	0.00	0.00	0.01	0.00	0.27	0.00	0.00
2	6.10	19.50	47.76	3.55	0.23	5.91	0.04	1.62	11.80	0.03	31.20	62.77	18.27	10.88	80.66	2.65	0.12	51.40	6.08	7.47	0.73	0.73
3	15.16	7.52	25.21	63.76	5.28	1.81	8.36	0.16	2.43	12.11	0.07	16.39	54.79	17.76	1.04	79.90	10.47	0.96	47.64	13.14	8.93	4.35
4	28.40	10.07	3.98	17.16	46.84	6.18	3.39	8.89	0.58	2.56	12.11	0.06	14.95	40.68	5.68	2.30	68.63	4.33	5.46	32.04	11.48	12.56
5	23.86	21.09	4.03	3.34	28.20	55.57	5.12	3.29	5.76	1.20	1.88	2.72	0.16	13.35	5.41	5.85	6.24	32.07	6.75	4.67	37.06	8.13
6	8.21	17.17	7.32	3.81	4.76	17.91	53.05	4.13	5.76	5.42	1.45	0.10	2.23	0.06	4.41	6.10	6.10	4.02	25.66	10.41	6.24	41.13
7	5.72	7.37	4.69	3.78	4.41	3.83	17.76	48.11	6.94	3.69	3.88	0.11	0.29	1.97	0.06	1.73	5.64	4.85	4.63	26.50	6.25	5.71
8	3.80	4.00	1.60	2.59	4.68	2.89	3.01	19.47	37.95	3.51	0.85	2.85	0.29	0.43	0.60	0.19	1.72	1.46	2.48	2.98	26.21	11.82
9+	5.89	5.83	2.34	1.96	4.16	5.87	9.26	14.06	28.77	69.98	25.94	14.54	6.87	12.85	2.13	1.27	1.06	0.90	1.30	2.52	3.11	15.57

Table 14. Yearly mean weights (kg, whole) of haddock by age-group, as observed from samples of USA commercial landings from Georges Bank (NAFO Subdivision 52e) during 1963-1984. Values in parentheses are estimates based on the mean of the weights for 1963-1979 (age 1) or 1979-1983 (all ages) for 1984.

AGE	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980 ¹	1981 ¹	1982 ¹	1983 ¹	1984 ²
1	0.57	0.50	0.58	0.58	0.66	0.59	0.52	0.71	(0.60)	0.62	(0.60)	0.72	0.62	(0.60)	(0.60)	(0.60)	(0.60)	(0.60)	(0.60)	(0.60)	(0.60)	(0.60)
2	0.87	0.83	0.69	0.73	0.70	0.81	0.78	1.27	1.03	1.03	1.03	1.06	0.98	0.99	1.07	0.94	1.00	0.72	0.91	0.92	1.00	0.86
3	1.18	1.12	1.03	0.89	0.95	1.05	1.10	1.22	1.31	1.74	1.58	1.82	1.63	1.39	1.44	1.50	1.28	1.20	1.24	1.41	1.43	1.31
4	1.47	1.43	1.35	1.26	1.18	1.32	1.69	1.93	1.74	2.04	2.13	2.32	2.21	1.99	2.17	2.04	2.02	1.93	1.80	1.94	1.94	1.74
5	1.68	1.64	1.67	1.70	1.42	1.57	1.75	2.19	2.39	2.42	2.41	2.83	2.20	2.66	2.73	2.79	2.51	2.30	2.40	2.44	2.31	2.17
6	2.15	2.01	1.99	2.07	2.05	2.10	1.99	2.39	2.81	2.92	3.29	3.76	2.94	2.63	3.21	3.19	3.14	2.94	2.80	2.83	2.80	2.67
7	2.35	2.40	2.26	2.28	2.31	2.32	2.52	2.58	2.92	3.06	3.42	4.05	4.00	3.69	4.15	3.37	3.78	3.86	3.73	3.35	3.38	2.98
8	3.04	2.64	2.66	2.87	2.66	2.62	2.99	3.23	3.10	3.44	3.86	3.92	4.05	4.67	4.00	3.61	3.79	4.13	4.44	4.00	3.59	3.39
9+	3.10	2.97	3.11	3.18	3.10	2.86	3.63	3.75	3.72	3.66	3.94	4.26	4.33	4.94	4.99	5.11	4.87	4.83	4.04	3.73	3.89	3.62

¹Overholtz (pers. comm.).

²Provisional.

Table 15. First quarter weights at age from U.S. commercial catch.

AGE	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	0.66	0.66	0.61	0.45	0.54	0.86	0.89	0.92	0.79	0.81	0.82	0.76	0.85	0.98	0.72	0.73	0.72	0.72	0.76	0.60	0.75	0.75
3	0.94	0.94	0.96	0.81	0.84	0.91	0.54	0.76	0.97	1.50	1.49	1.47	1.53	1.57	1.46	1.28	1.02	1.20	1.09	1.22	1.21	1.27
4	1.41	1.53	1.25	1.22	1.09	1.20	1.64	1.77	1.47	1.72	2.12	2.24	2.36	2.16	2.03	1.68	1.82	1.93	1.40	1.79	1.71	1.84
5	1.55	1.70	1.67	1.94	1.69	1.43	1.69	1.92	2.12	2.90	2.21	2.15	1.96	2.24	2.52	2.45	2.39	2.30	1.78	2.62	2.21	2.27
6	1.92	1.86	1.89	2.05	1.97	1.82	1.91	2.08	2.38	2.73	2.03	2.43	2.82	2.96	3.09	3.20	2.81	2.94	2.68	2.55	2.68	2.49
7	2.03	1.98	2.24	2.27	2.40	2.10	2.42	2.53	2.66	2.91	3.03	3.18	3.32	3.60	3.60	3.41	3.37	3.86	3.23	3.24	3.71	2.98
8	2.38	2.08	2.62	2.77	2.57	2.38	3.13	2.92	2.82	3.24	3.27	3.72	4.54	4.67	3.88	3.74	3.38	4.13	4.31	3.66	3.50	3.41
9+	2.64	2.16	3.12	3.06	3.15	2.73	3.75	3.76	3.62	3.49	3.66	4.34	4.64	4.82	4.90	4.81	4.75	4.83	4.32	4.61	3.95	3.61

Table 16. Stratified mean catch per tow in numbers and weight (kg) for haddock in offshore spring, summer, and autumn¹ US bottom trawl surveys on Georges Bank, 1963-1985. (From Clark et al. 1982; Overholtz 1982 and Overholtz et al. 1983, --- denotes no data available).

Year	Spring ^{1,2}		Autumn ¹	
	Nos.	Wt.(kg)	Nos.	Wt.(kg)
1963	---	---	97.34	52.83
1964	---	---	129.70	64.07
1965	---	---	68.26	48.20
1966	---	---	22.32	19.78
1967	---	---	11.88	16.87
1968	9.15	13.61	5.06	10.20
1969	4.86	11.21	2.28	5.59
1970	4.02	11.34	5.17	8.94
1971	1.87	3.31	2.83	3.70
1972	4.27	4.88	7.62	5.61
1973	25.23	10.18	9.98	6.48
1974	12.77	11.72	2.71	2.64
1975	4.18	5.44	20.78	10.00
1976	55.83	10.41	47.68	23.68
1977	24.74	17.60	19.02	23.13
1978	13.03	20.71	20.70	15.18
1979	30.53	13.09	42.74	26.87
1980	40.32	35.71	24.98	18.47
1981	25.53	31.95	11.01	11.77
1982	7.27	11.01	3.66	4.86
1983	3.77	8.75	5.37	3.81
1984 ³	4.21	4.93	3.62	2.97
1985 ³	8.40	10.28		

¹Spring and autumn surveys covered strata 13-25, 29, and 30.

²Data for the spring, 1968-1972 and 1982-1984 surveys were not adjusted to account for differences in surface area between the "36 Yankee" and the modified "41 Yankee" trawls (the "41 Yankee" was used in spring during 1973-1981).

³Preliminary data from (Overholtz pers. comm.). Portuguese oval doors were used rather than BMB doors. Value probably 20-30% higher.

Table 17. Stratified mean catch per tow at age (numbers) for haddock in NEFC offshore spring and autumn¹ bottom trawl surveys on Georges Bank 1963-1984 (modified from Clark et al. 1982 and Overholtz et al. 1983).

Year	AGE											TOTALS ²		
	0	1	2	3	4	5	6	7	8	9	0+ ²	1+ ²	2+	
<u>Spring</u>														
1968 ³	0.0	0.27	1.90	0.31	0.47	4.51	1.13	0.17	0.30	0.23	-	9.29	9.02	
1969	0.0	0.00	0.05	0.39	0.17	0.28	2.84	0.69	0.19	0.31	-	4.85	4.85	
1970	0.0	0.45	0.17	0.00	0.22	0.31	0.31	1.34	0.66	0.57	-	4.03	3.58	
1971	0.0	0.00	0.78	0.17	0.00	0.08	0.08	0.06	0.55	0.15	-	1.87	1.87	
1972	0.0	2.70	0.06	0.41	0.08	0.02	0.03	0.09	0.02	0.87	-	4.28	1.58	
1973	0.0	20.59	3.25	0.00	0.36	0.06	0.00	0.12	0.01	0.86	-	25.25	4.66	
1974	0.0	1.43	8.92	1.92	0.00	0.16	0.00	0.01	0.07	0.25	-	12.76	11.33	
1975	0.0	0.63	0.65	2.23	0.42	0.00	0.09	0.06	0.01	0.10	-	4.19	3.56	
1976	0.0	54.22	0.20	0.40	0.62	0.29	0.00	0.03	0.00	0.07	-	55.83	1.61	
1977	0.0	0.41	22.42	0.28	0.82	0.40	0.30	0.00	0.03	0.08	-	24.74	24.33	
1978 ⁴	0.0	0.05	0.65	10.69	0.24	0.63	0.55	0.11	0.04	0.07	-	13.03	12.98	
1979	0.0	24.24	1.06	0.76	3.83	0.22	0.11	0.25	0.04	0.03	-	30.54	6.30	
1980	0.0	3.49	31.34	0.34	0.70	3.27	0.45	0.25	0.31	0.16	-	40.31	36.82	
1981 ⁴	0.0	2.70	2.69	15.95	1.79	0.62	1.46	0.20	0.09	0.04	-	25.53	22.83	
1982	0.0	0.62	1.25	0.77	3.33	0.34	0.23	0.50	0.00	0.00	-	7.04	6.42	
1983	0.0	0.29	0.37	0.39	0.15	1.62	0.01	0.03	0.78	0.12	-	3.76	3.47	
1984 ⁵	0.0	1.40	0.79	0.43	0.42	0.39	0.48	0.05	0.03	0.20	-	4.19	2.79	
<u>Autumn</u>														
1963	56.33	17.04	6.19	4.57	5.60	3.99	1.37	1.13	0.79	0.31	97.32	40.99	23.95	
1964	1.59	75.75	42.78	3.91	1.20	2.56	1.05	0.46	0.17	0.22	129.69	128.10	52.35	
1965	0.22	6.82	51.94	6.51	0.72	0.54	0.61	0.54	0.17	0.18	68.25	68.03	61.21	
1966	4.12	0.64	1.94	12.34	2.25	0.35	0.33	0.22	0.08	0.05	22.32	18.20	17.36	
1967	0.02	4.51	0.24	0.67	4.54	1.09	0.33	0.14	0.22	0.12	11.88	11.86	7.35	
1968	0.06	0.04	0.64	0.09	0.22	2.59	0.85	0.18	0.11	0.26	5.04	4.98	4.94	
1969	0.26	0.02	0.00	0.19	0.09	0.11	1.02	0.34	0.06	0.18	2.27	2.01	1.99	
1970	0.03	2.77	0.14	0.01	0.19	0.18	0.34	0.92	0.32	0.27	5.17	5.14	2.37	
1971	1.63	0.00	0.21	0.05	0.01	0.15	0.02	0.06	0.50	0.19	2.82	1.19	1.19	
1972	4.53	1.69	0.00	0.35	0.06	0.00	0.06	0.04	0.02	0.87	7.62	3.09	1.40	
1973	2.17	6.04	1.08	0.00	0.13	0.03	0.00	0.05	0.01	0.48	9.99	7.82	1.78	
1974	0.50	1.19	0.66	0.21	0.00	0.01	0.00	0.00	0.00	0.15	2.72	2.22	1.03	
1975	15.76	0.42	0.48	3.26	0.62	0.00	0.02	0.00	0.01	0.20	20.77	5.01	4.59	
1976	2.90	43.07	0.35	0.36	0.55	0.20	0.00	0.03	0.07	0.17	47.70	44.80	1.73	
1977	0.11	1.75	15.33	0.46	0.47	0.52	0.28	0.03	0.01	0.07	19.03	18.92	17.17	
1978	10.82	0.69	0.85	7.59	0.15	0.21	0.37	0.01	0.00	0.01	20.70	9.88	9.19	
1979	1.08	37.29	0.03	0.74	3.12	0.21	0.23	0.04	0.01	0.00	42.75	41.67	4.38	
1980	9.56	2.22	10.41	0.37	0.25	1.39	0.39	0.38	0.07	0.05	24.99	15.43	13.21	
1981	0.31	5.02	1.70	3.03	0.17	0.34	0.43	0.00	0.00	0.01	11.01	10.70	5.68	
1982	0.89	0.00	0.74	0.32	1.27	0.13	0.07	0.19	0.01	0.05	3.67	2.78	2.78	
1983	3.89	0.16	0.14	0.18	0.20	0.63	0.08	0.00	0.07	0.01	5.36	1.47	1.31	
1984 ⁵	0.02	2.23	0.59	0.16	0.19	0.04	0.30	0.00	0.00	0.08	3.61	3.59	1.36	
<u>Spring</u>														
Instantaneous ⁶				'79-'80	0.524				'79-'80	0.698				
Total Mortality				'81-'82	0.750				'81-'82	0.950				
				'83-'84	0.582				'83-'84	0.712				

¹Spring and autumn, strata 13-25, 29, and 30; summer, strata 13, 16, and 19-25 (see Fig. 4).

²May not agree exactly with data in Table 2 due to rounding errors.

³Data for 1968-1972 and 1982-1984 were not adjusted to account for differences in surface area between the "36 Yankee" and the modified "41 Yankee" trawls (the modified "41 Yankee" has been used in spring from 1973 to 1981).

⁴Sampling incomplete in 1978 and 1981 (7 strata sampled).

⁵Preliminary.

⁶Calculated by pooling over age groups, e.g. the spring 1973-1976 fish was calculated as:

$$-\ln \left(\frac{\text{age 4 to 8 (year x+1)}}{\text{age 3 to 7 (year x)}} \right). \text{ Adjacent years were then averaged.}$$

Table 18. Recruitment indices¹ of Georges Bank (NAFO Subdivision 5Ze) haddock for the 1963-1984 year-classes.

Year-Class	Age 0+1 Index	Rank
1963	9.200	1
1964	0.515	
1965	0.550	
1966	0.617	
1967	0.004	
1968	0.006	
1969	0.175	
1970	0.003	
1971	0.239	
1972	0.737	5
1973	0.260	
1974	0.068	
1975	3.768	2
1976	0.356	
1977	0.480	
1978	3.009	3
1979	0.218	
1980	1.134	4
1981	0.028	
1982	0.089	
1983 ²	0.472	
1984 ²	0.004	

¹Calculated as:

$$\left(\frac{\text{age 0 no. per tow (year x)}}{\text{mean no. per tow ('63-'83)}} + \frac{\text{age 1 no. per tow (year x+1)}}{\text{mean no. per tow ('64-'84)}} \right) \div 2$$

²Based on 0 age-group estimate only.

Table 19. June to September CPUE indices for TC 4 and 5 stern trawlers. Only "main species" trips were considered.

Year	Total Landings (t) for gear	Landings with effort (t)	Hours fished	CPUE	% ¹
TC 5 Stern Trawlers					
1968	3786	479	1266	0.378	12.7
1969	2928	502	1448	0.347	17.2
1970	1186	288	1078	0.267	24.3
1971	965	109	497	0.219	11.4
1972	263	11	65	0.169	4.2
1973	766	364	1589	0.229	47.5
1974	334	36	113	0.319	10.8
1975	963	161	608	0.265	16.7
1976	908	315	905	0.348	34.7
1977	2052	568	1112	0.511	27.7
1978	5734	139	346	0.402	2.4
1979	1565	303	475	0.638	19.4
1980	6323	3677	5408	0.680	58.2
1981	2348	594	1219	0.487	25.3
1982	3359	735	1284	0.572	22.0
1983	1135	293	615	0.476	26.0
1984	149	24	104	0.231	16.1
TC 4 Stern Trawlers					
1968	580	5	26	0.192	0.9
1973	61	36	187	0.193	59.0
1975	60	27	69	0.391	45.0
1976	61	54	192	0.281	88.5
1978	351	17	25	0.680	4.8
1979	651	262	388	0.675	40.2
1980	1016	545	897	0.608	53.6
1981	884	565	1045	0.541	63.4
1982	250	31	102	0.304	12.4
1983	107	15	79	0.190	14.0
1984	21	4	20	0.200	19.0

¹% of landings with appropriate effort data.

Table 20. 1964-1985 age 3+ numbers from cohort analyses conducted at difference levels of terminal F vs the corresponding 2+ numbers from the previous fall NEFC groundfish survey. Data were ln transformed and constrained by a slope of 1 and 3+ numbers for 1985 were calculated using $N_t = N_0 e^{-Z}$.

Cohort year	Fall RV 2+	Terminal F									
		0.30		0.40		0.45		0.50		0.60	
		3+ Cohort	Residuals	3+ Cohort	Residuals	3+ Cohort	Residuals	3+ Cohort	Residuals	3+ Cohort	Residuals
1964	23.95	99852	-0.367	99802	-0.305	99785	-0.282	99772	-0.261	99781	-0.228
1965	52.35	166804	-0.635	166683	-0.574	166642	-0.551	166610	-0.531	166594	-0.497
1966	61.21	270788	-0.307	270505	-0.246	270411	-0.223	270336	-0.203	270249	-0.170
1967	17.56	112702	0.065	112457	0.125	112375	0.148	112310	0.167	112230	0.200
1968	7.35	60452	0.313	60249	0.372	60182	0.394	60128	0.413	60061	0.446
1969	4.94	34396	0.146	34186	0.202	34116	0.224	34061	0.242	33987	0.274
1970	1.99	19018	0.463	18838	0.516	18778	0.536	18730	0.554	18666	0.583
1971	2.37	12363	-0.142	12211	-0.093	12160	-0.073	12120	-0.056	12061	-0.028
1972	1.19	10504	0.384	10340	0.430	10285	0.448	10242	0.464	10177	0.491
1973	1.40	4253	-0.683	4172	-0.640	4146	-0.623	4125	-0.608	4093	-0.582
1974	1.78	8234	-0.263	8055	-0.222	7996	-0.206	7949	-0.192	7878	-0.168
1975	1.03	11329	0.604	11125	0.647	11058	0.665	11004	0.680	10924	0.706
1976	4.59	13800	-0.693	13430	-0.659	13308	-0.644	13210	-0.631	13064	-0.609
1977	1.73	15161	0.376	14598	0.401	14412	0.411	14263	0.421	14040	0.439
1978	17.17	66355	-0.442	63822	-0.419	62981	-0.409	62310	-0.399	61309	-0.382
1979	9.19	49926	-0.102	46997	-0.100	46025	-0.098	45250	-0.094	44094	-0.087
1980	4.38	35754	0.305	32974	0.286	32051	0.282	31315	0.279	30217	0.276
1981	13.21	50749	-0.456	45933	-0.494	44334	-0.505	43060	-0.514	41158	-0.526
1982	5.68	34111	-0.002	29670	-0.079	28196	-0.106	27021	-0.129	25268	-0.163
1983	2.78	25665	0.428	21290	0.304	19837	0.256	18679	0.217	16952	0.153
1984	1.31	16647	0.748	13065	0.568	11877	0.496	10929	0.433	9516	0.328
1985	1.36	10614	0.260	7549	-0.018	6533	-0.139	5723	-0.251	4516	-0.455
		Intercept									
		8.702		8.640		8.613		8.596		8.563	
		Sum of Residuals Squared									
All Years		3.978		3.542		3.464		3.444		3.525	
Last 6		1.112		0.747		0.677		0.656		0.717	
Last 5		1.019		0.665		0.598		0.579		0.641	
Last 4		0.811		0.421		0.343		0.314		0.364	
Last 3		0.627		0.415		0.331		0.298		0.338	

Table 21. 1968-1984 ln fishable biomass from cohort analyses conducted at different levels of terminal F vs ln CPUE for TC 5 stern trawlers (constrained by a slope of 1).

Cohort year	TC 5 CPUE	Terminal F									
		0.30		0.40		0.45		0.50		0.60	
		Fishable Biomass	Residuals	Fishable Biomass	Residuals	Fishable Biomass	Residuals	Fishable Biomass	Residuals	Fishable Biomass	Residuals
1968	0.378	77940	0.418	77591	0.482	77479	0.506	77383	0.526	77258	0.560
1969	0.347	51254	0.084	50870	0.145	50743	0.168	50641	0.188	50515	0.221
1970	0.267	40712	0.116	40271	0.174	40125	0.195	40008	0.214	39855	0.246
1971	0.219	31547	0.059	31093	0.113	30942	0.134	30821	0.152	30646	0.181
1972	0.169	27188	0.170	26694	0.220	26530	0.239	26399	0.256	26205	0.284
1973	0.229	20062	-0.438	19696	-0.388	19567	-0.369	19477	-0.352	19359	-0.323
1974	0.319	31898	-0.306	31235	-0.258	31015	-0.240	30839	-0.224	30575	-0.197
1975	0.265	25388	-0.349	24845	-0.302	24682	-0.283	24521	-0.268	24245	-0.244
1976	0.348	27630	-0.536	26857	-0.496	26622	-0.480	26396	-0.467	26013	-0.446
1977	0.511	105052	0.415	101489	0.449	100306	0.462	99362	0.475	97954	0.496
1978	0.402	91191	0.513	87110	0.536	85787	0.546	84673	0.555	82946	0.569
1979	0.638	80531	-0.073	75371	-0.071	73659	-0.068	72291	-0.065	70248	-0.059
1980	0.680	95808	0.037	88122	0.022	85566	0.018	83525	0.015	80477	0.014
1981	0.487	77942	0.165	68907	0.110	65858	0.090	63504	0.075	60080	0.055
1982	0.572	69017	-0.118	58669	-0.212	55248	-0.247	52482	-0.276	48313	-0.324
1983	0.476	52049	-0.216	42065	-0.361	38748	-0.418	36095	-0.467	32125	-0.548
1984	0.231	33256	0.059	24942	-0.161	22171	-0.253	19954	-0.337	16628	-0.484
		Intercept									
		11.819		11.750		11.725		11.703		11.668	
		Sum of Residuals Squared									
All Years		1.456		1.607		1.726		1.861		2.153	
Last 6		0.098		0.219		0.312		0.418		0.646	
Last 5		0.093		0.214		0.308		0.414		0.642	
Last 4		0.091		0.213		0.307		0.413		0.642	
Last 3		0.064		0.156		0.299		0.408		0.639	

Table 22. Predicted population numbers at age 1 and 2 from various RV/cohort relationships using F recruited) = 0.50 and F on age 2 = 0.23. Both relationships are constrained to a slope of 1.

Relationship	Fig.	Intercept	Age Predicted	Year-Class	Year of Prediction	Estimated No. (000's)
ln (Fall RV 0) = ln (cohort 1)	16	8.9250	1	1983	1984	29,243
ln (Fall RV 0) = ln (cohort 1)	16	8.9250	1	1984	1985	150
ln (Fall RV 1) = ln (cohort 2)	15	8.3614	2	1982	1984	685
ln (Fall RV 1) = ln (cohort 2)	15	8.3614	2	1983	1985	9,541

Table 23. Results of cohort analyses based on a terminal F of 0.50 for fully recruited ages, and F = 0.23 for age 2 (1984). Population numbers for 1985, ages 3-9+ were derived from $N_{t+1} = N_t \times e^{-Z}$. See Table 22 and text for details of population estimates for age 1 (1984 and 1985) and age 2 (1985).

POPULATION NUMBERS																							
	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1 1	190772	472067	33170	4139	12998	424	989	4674	385	8546	19506	10665	8145	104077	14233	5516	79771	8688	6804	1577	555	20448	385
2 1	32301	153558	377356	18470	3286	9602	340	808	3785	315	6855	13654	8691	6495	85736	11653	4516	65311	7106	5571	1221	455	16742
3 1	32745	22784	111304	195108	8930	2538	5152	268	519	1855	256	3751	7270	6180	4889	52474	8852	3674	25422	4315	3273	921	296
4 1	45825	20098	14533	50866	68524	4696	1436	2682	205	223	1111	207	2477	4265	4562	3834	29937	5686	2694	12173	2054	2002	458
5 1	29029	27427	12133	7052	24303	37403	2106	771	1680	132	109	561	168	1689	2696	3120	2863	18023	3773	1523	7346	1040	994
6 1	9184	16349	14563	5961	3269	10543	17485	1133	463	1114	79	41	396	134	1187	1741	2041	1869	9278	2456	944	4274	516
7 1	5591	5524	8143	5870	2536	1583	5466	8928	734	156	803	37	32	286	108	649	958	1300	993	5535	1427	531	2122
8 1	2792	3306	2639	3254	2696	1177	683	3051	5222	343	57	588	29	23	213	85	405	499	570	534	3277	968	264
9 1	4244	4284	3295	2225	2052	2189	1731	1898	3299	6420	1709	2763	633	634	607	408	194	264	330	485	358	1193	1073
1+	352483	725396	577136	292945	128594	70153	35389	24212	16289	19102	30486	32268	27839	124582	114232	79479	129537	105314	56970	34169	20455	31832	22850
2+	161711	253330	543966	288806	115596	69730	34400	19538	15905	10557	10980	21602	19695	19704	99999	73963	49766	96626	50165	32592	19900	11384	22465
3+	129410	99772	166610	270336	112310	60128	34061	18730	12120	10242	4125	7949	11004	13210	14263	62310	45250	31315	43060	27021	18679	10929	5723
4+	96665	76988	55306	75228	103380	57590	28908	18462	11601	8387	3869	4197	3734	7030	9373	9836	36398	27641	17638	22706	15407	10008	5427

CATCH BIOMASS																						
	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1 1	1659	5051	5569	66	759	5	1	33	0	97	1536	33	119	86	0	0	0	5	0	47	0	0
2 1	3521	13226	86814	4995	118	2425	9	201	1416	2	2119	4579	1013	468	20956	715	26	22320	1511	1310	87	73
3 1	8753	5100	45831	89721	2746	744	1868	20	292	783	5	1196	3038	765	269	21593	2209	416	11842	2304	1070	434
4 1	16393	6830	7231	24150	24387	2536	757	1100	70	165	822	5	829	1751	1476	622	14481	1882	1357	5617	1376	1253
5 1	13773	14304	7333	4706	14680	22795	1145	407	691	77	128	198	9	575	1406	1582	1318	13924	1679	818	4443	812
6 1	4741	11646	13313	5363	2478	7348	11848	511	691	350	99	8	123	3	1146	1649	1287	1746	6379	1825	748	4104
7 1	3302	4997	8525	5317	2294	1571	3966	5955	832	239	263	8	16	85	17	468	1191	2108	1150	4646	750	569
8 1	2192	2714	2910	3639	2439	1187	673	2410	4554	227	58	208	16	19	156	51	364	632	615	522	3142	1180
9 1	3398	3956	4248	2757	2164	2408	2069	1740	3452	4524	1761	1061	381	553	554	342	224	391	324	442	372	1553
1+	57731	67823	181774	140715	52065	41018	22336	12376	11998	6464	6790	7295	5545	4304	25979	27023	21100	43424	24857	17531	11988	9977
2+	56072	62773	176205	140649	51306	41014	22335	12343	11998	6368	5254	7262	5426	4218	25979	27023	21100	43419	24857	17485	11988	9977
3+	52551	49547	89391	135653	51189	38589	22326	12143	10582	6366	3136	2683	4413	3750	5023	26307	21074	21099	23345	16175	11901	9904
4+	43798	44446	43560	45933	48442	37844	20458	12123	10290	5583	3131	1487	1374	2985	4754	4715	18865	20683	11503	13871	10831	9470

Table 23 (cont'd.). Results of cohort analyses based on a terminal F of 0.50 for fully recruited ages, and F = 0.23 for age 2 (1984). Population numbers for 1985, ages 3-9+ were derived from $N_{t+1} = N_t \times e^{-Z}$. See Table 22 and text for details of population estimates for age 1 (1984 and 1985) and age 2 (1985).

FISHING MORTALITY																						
	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	.017	.024	.385	.031	.103	.021	.002	.011	.000	.020	.157	.005	.026	.002	.000	.000	.000	.001	.000	.056	.000	~
2	.149	.122	.460	.527	.058	.423	.036	.243	.513	.007	.403	.430	.141	.084	.291	.075	.006	.744	.299	.332	.082	.230
3	.288	.250	.583	.846	.443	.369	.453	.068	.645	.312	.013	.215	.333	.104	.043	.361	.243	.110	.536	.542	.291	.500
4	.313	.305	.523	.539	.405	.602	.423	.268	.243	.514	.484	.011	.183	.259	.180	.092	.307	.210	.370	.305	.481	.500
5	.374	.433	.511	.569	.635	.560	.420	.310	.211	.313	.769	.149	.027	.152	.237	.224	.226	.464	.229	.279	.342	.500
6	.308	.497	.709	.655	.525	.457	.472	.234	.886	.127	.546	.055	.125	.008	.404	.398	.251	.433	.317	.343	.375	.500
7	.325	.539	.717	.578	.567	.640	.383	.336	.561	.802	.112	.061	.148	.093	.042	.270	.452	.624	.420	.324	.188	.500
8	.333	.417	.603	.555	.466	.546	.447	.313	.369	.238	.338	.105	.166	.216	.224	.199	.301	.409	.310	.312	.347	.500
9	.333	.417	.603	.555	.466	.546	.447	.313	.369	.238	.338	.105	.166	.216	.224	.199	.301	.409	.310	.312	.347	.500
3+	.322	.380	.591	.765	.468	.539	.448	.309	.388	.255	.329	.157	.277	.164	.164	.337	.290	.380	.444	.349	.339	.500

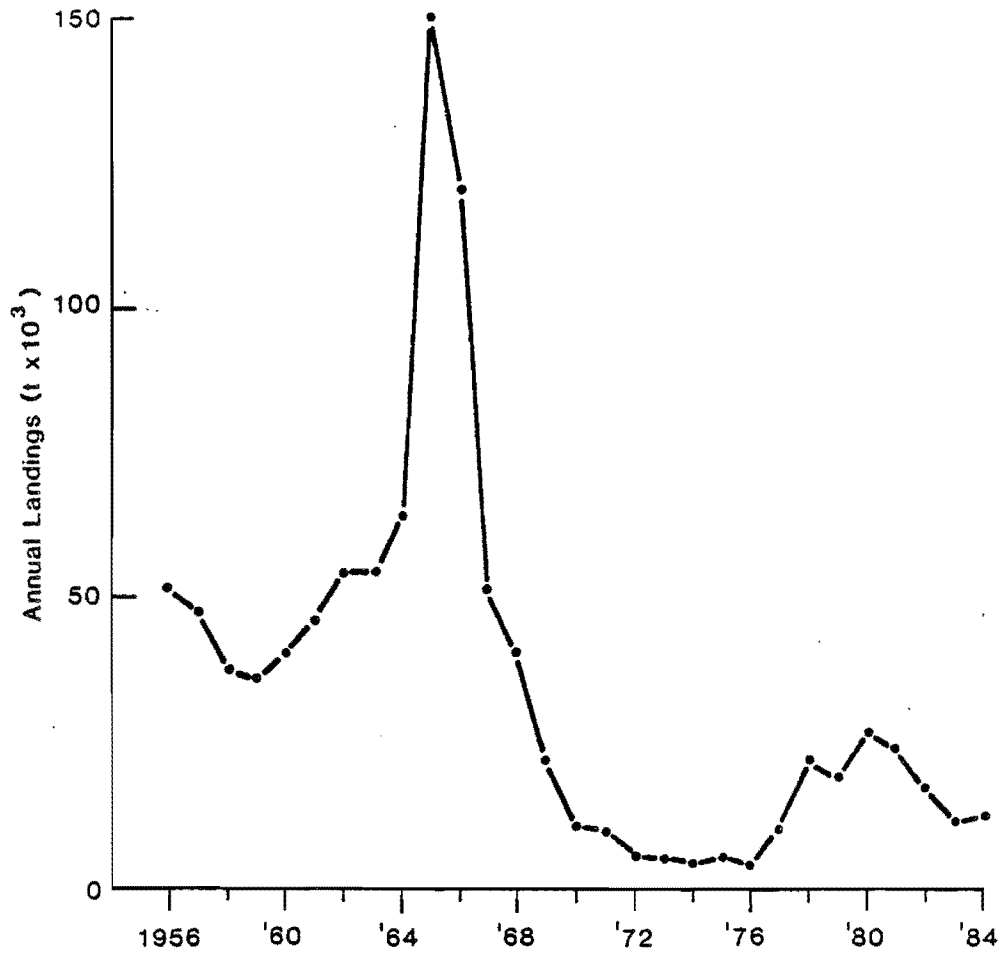


Fig. 1.. Nominal catches (t) of Georges Bank haddock from 1956-1984.

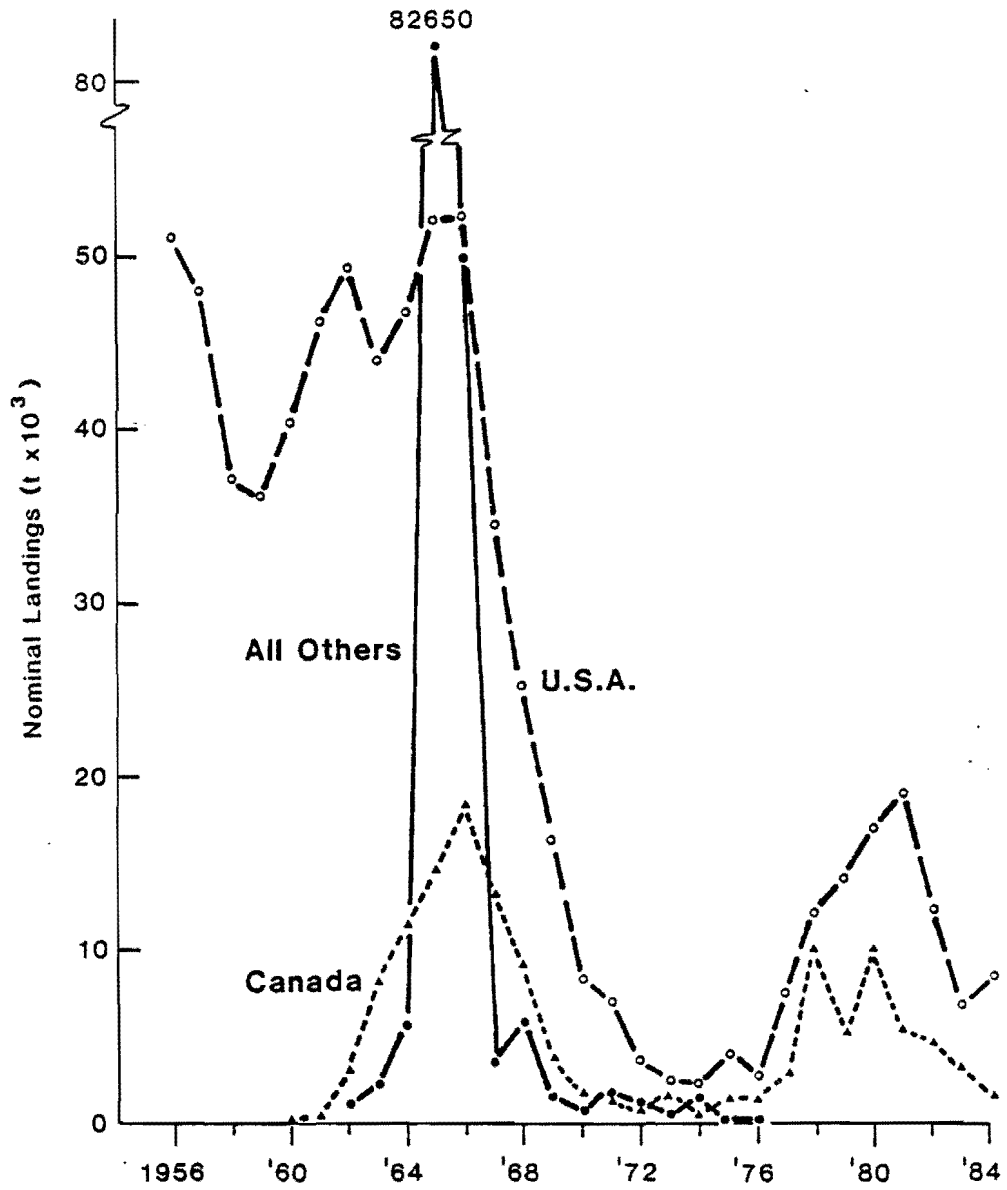


Fig. 2. Annual landings (t) by all countries fishing the Georges Bank haddock stock, 1956-1984.

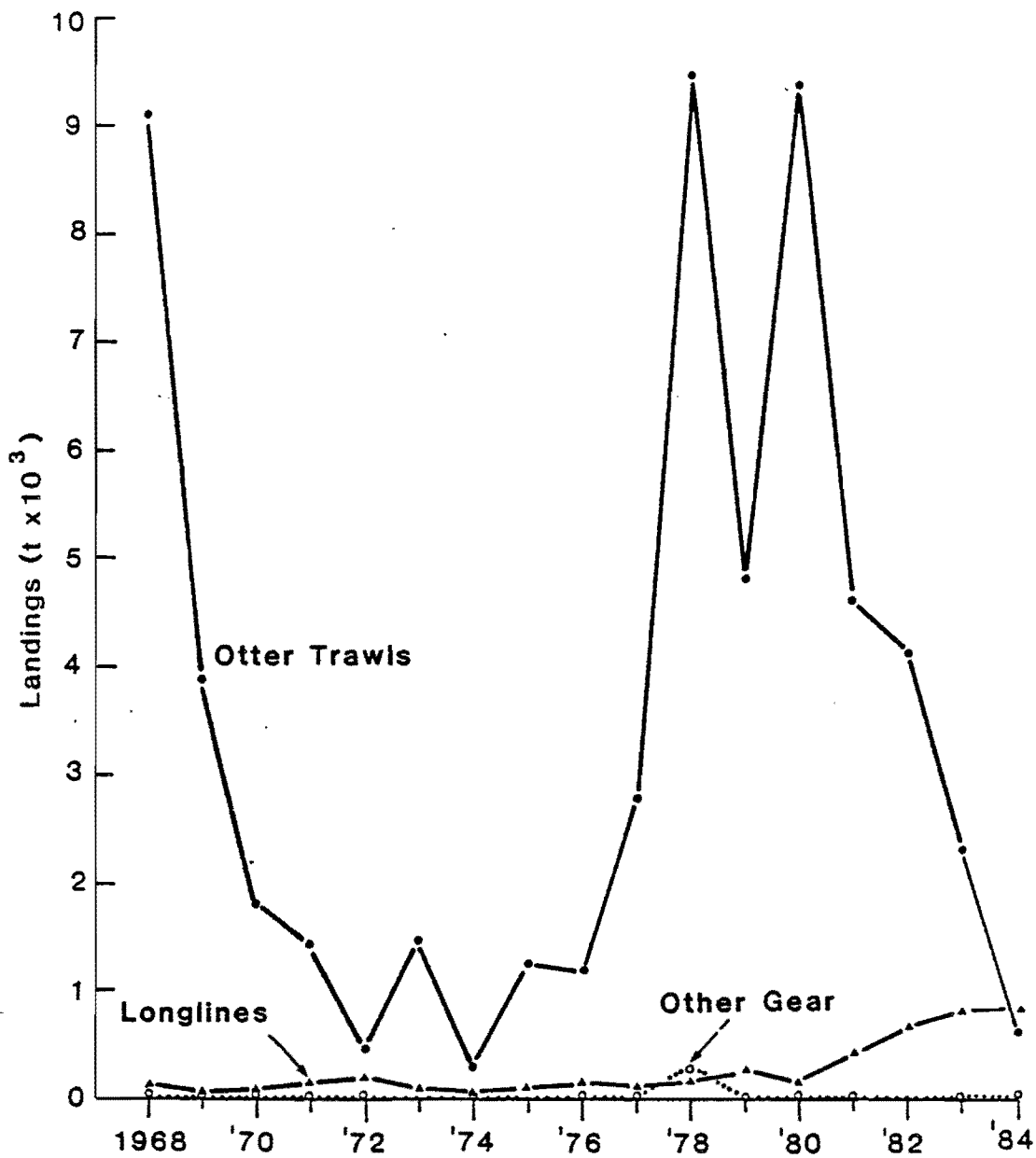


Fig. 3. Canadian landings of Georges Bank haddock, by gear type (1968-1984).

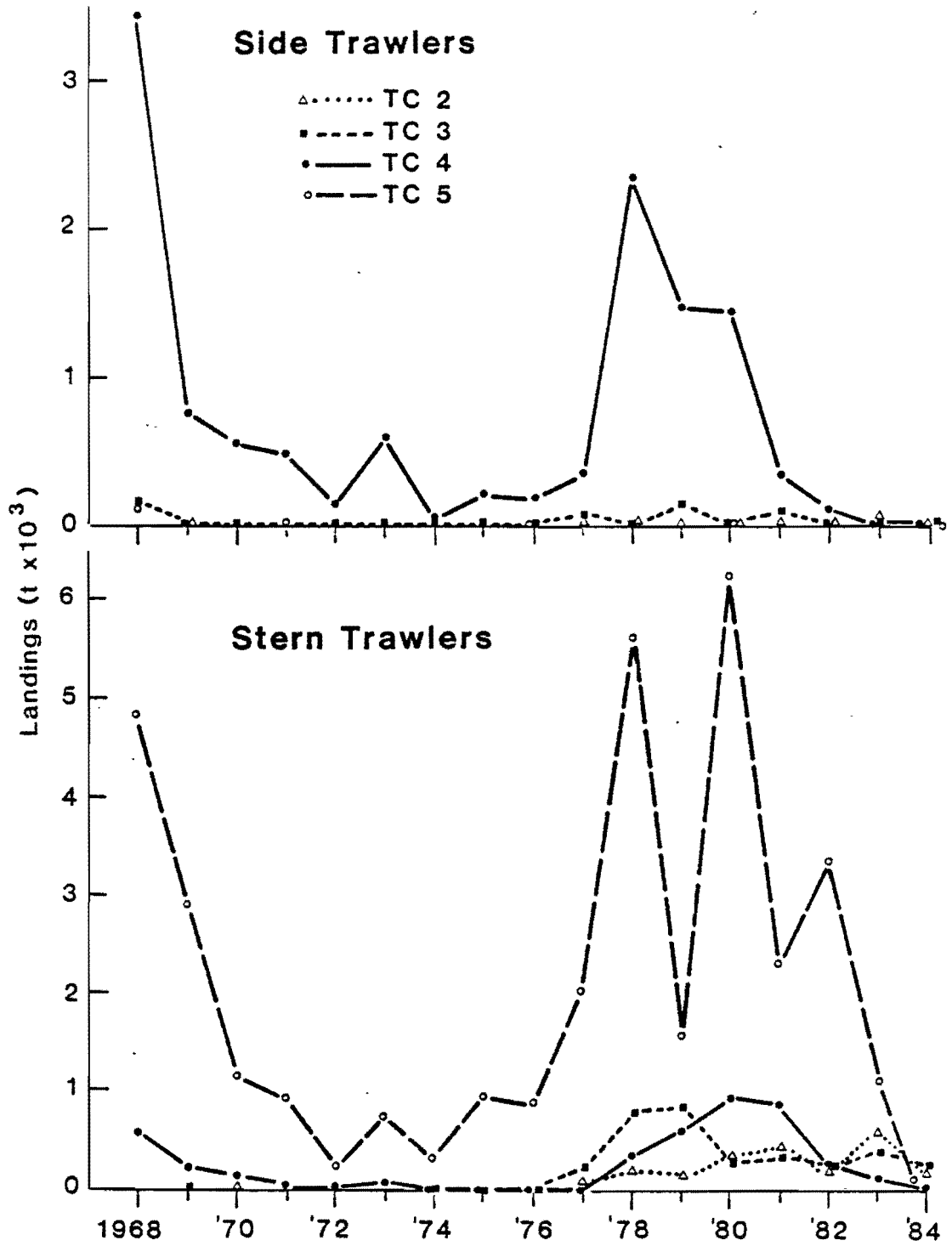


Fig. 4. Landings of Georges Bank haddock by Canadian side and stern trawlers, by Tonnage Class, 1968-1984.

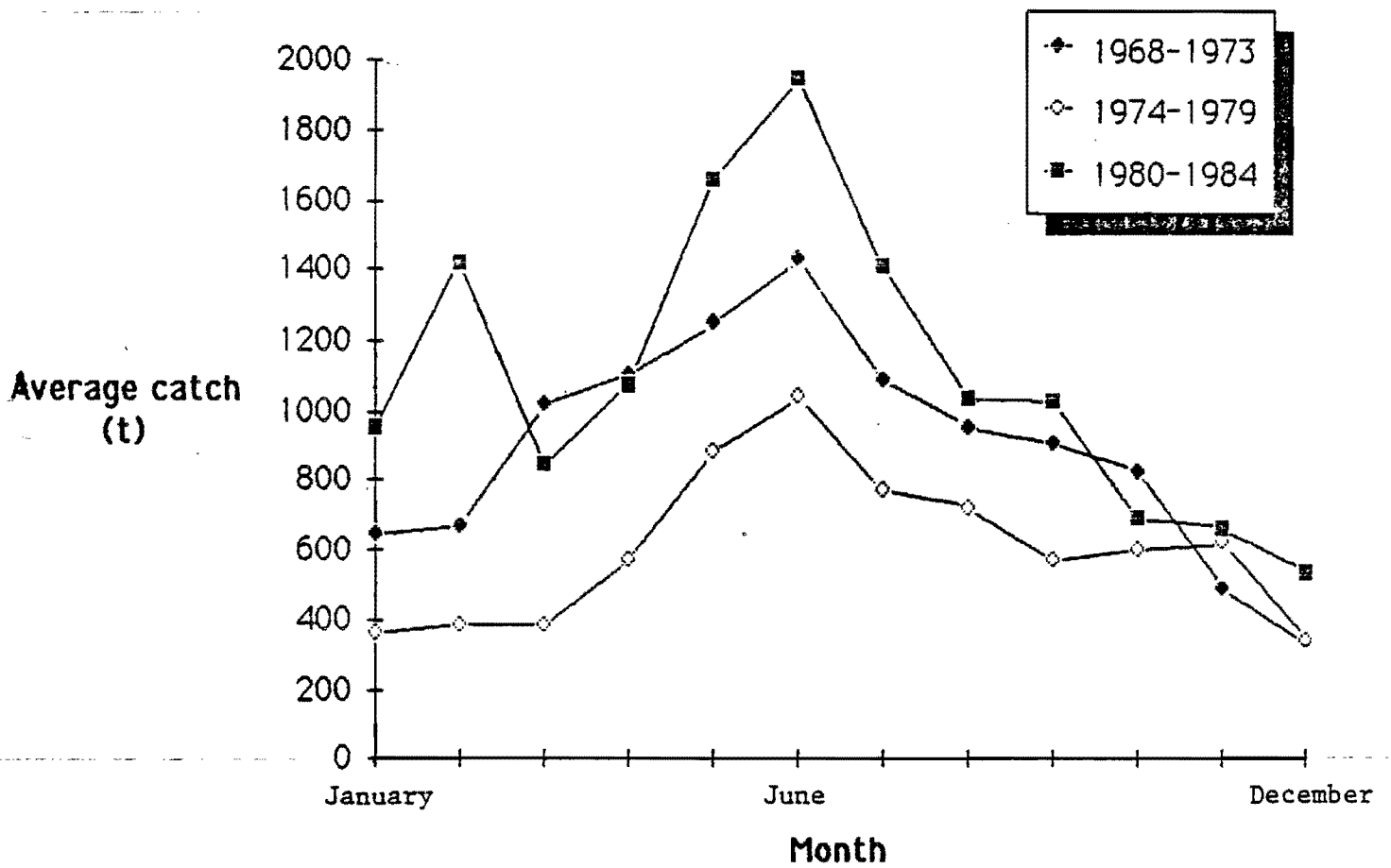


Fig. 5. Average monthly catch of 5Z haddock by the United States, summarized for the periods 1968-1973, 1974-1979 and 1980-1984.

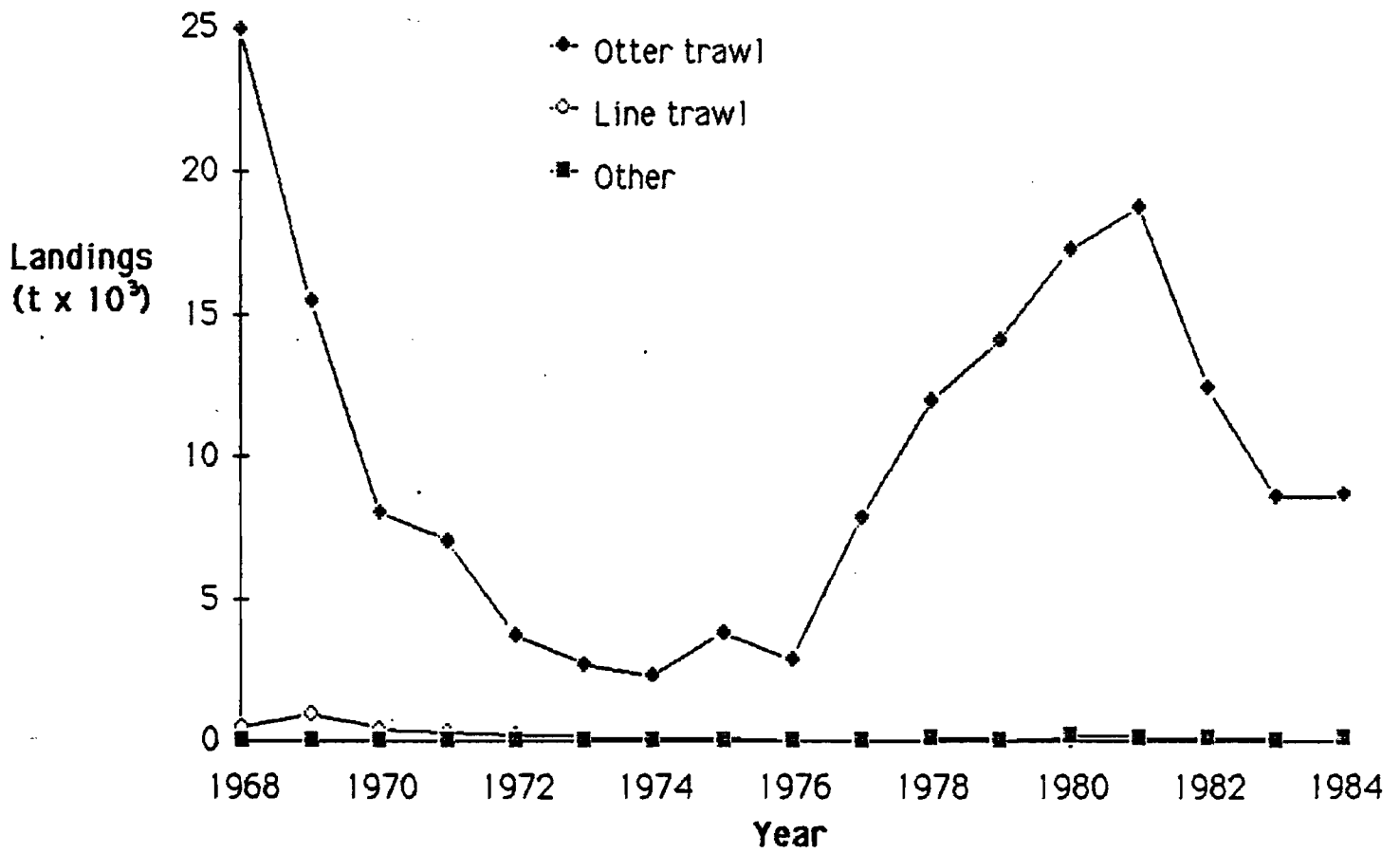


Fig. 6. United States landings of 5Z haddock, by gear type (1968-1984).

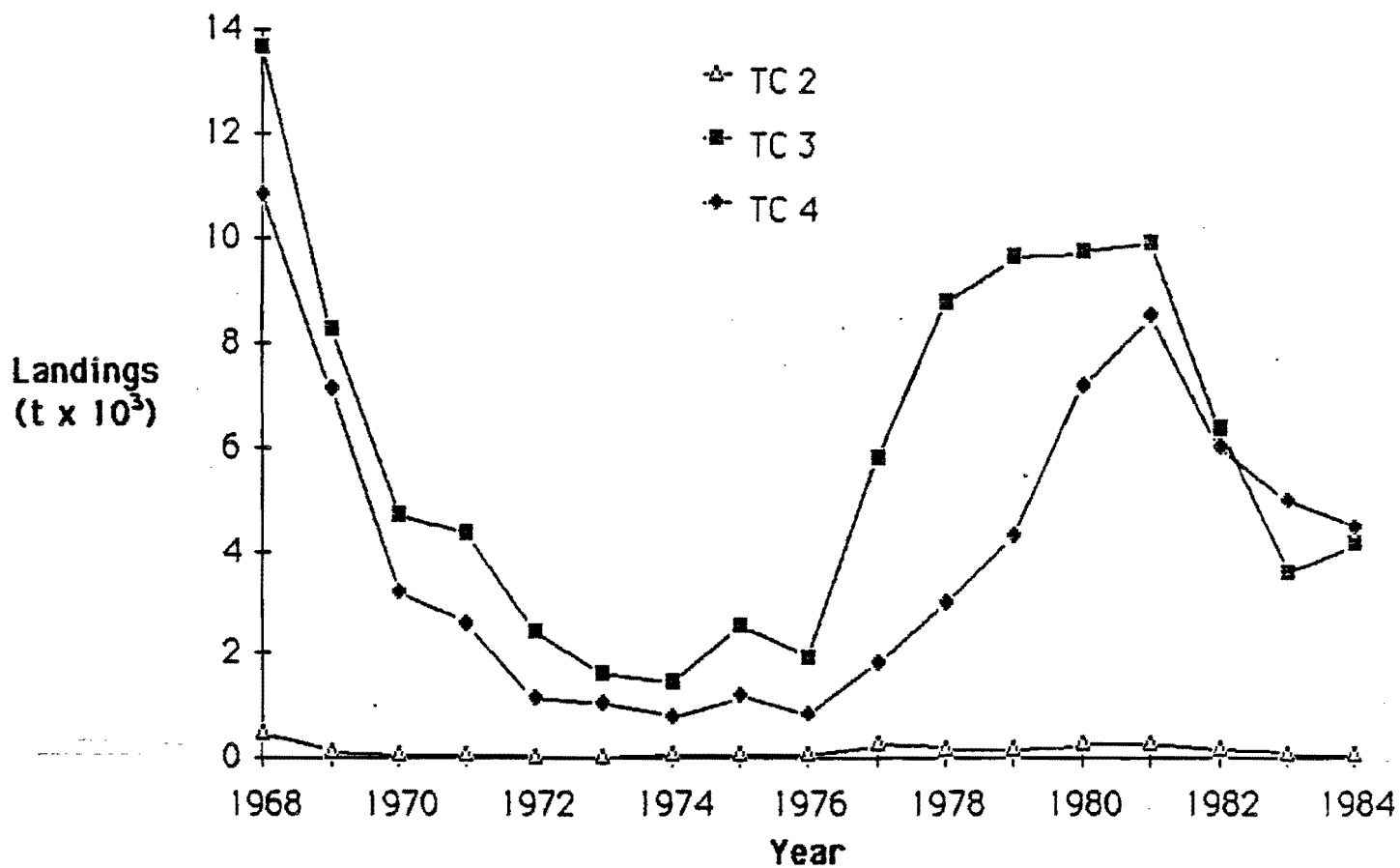


Fig. 7. United States landings of 5Z haddock, by Tonnage Class of otter trawlers (1968-1984).

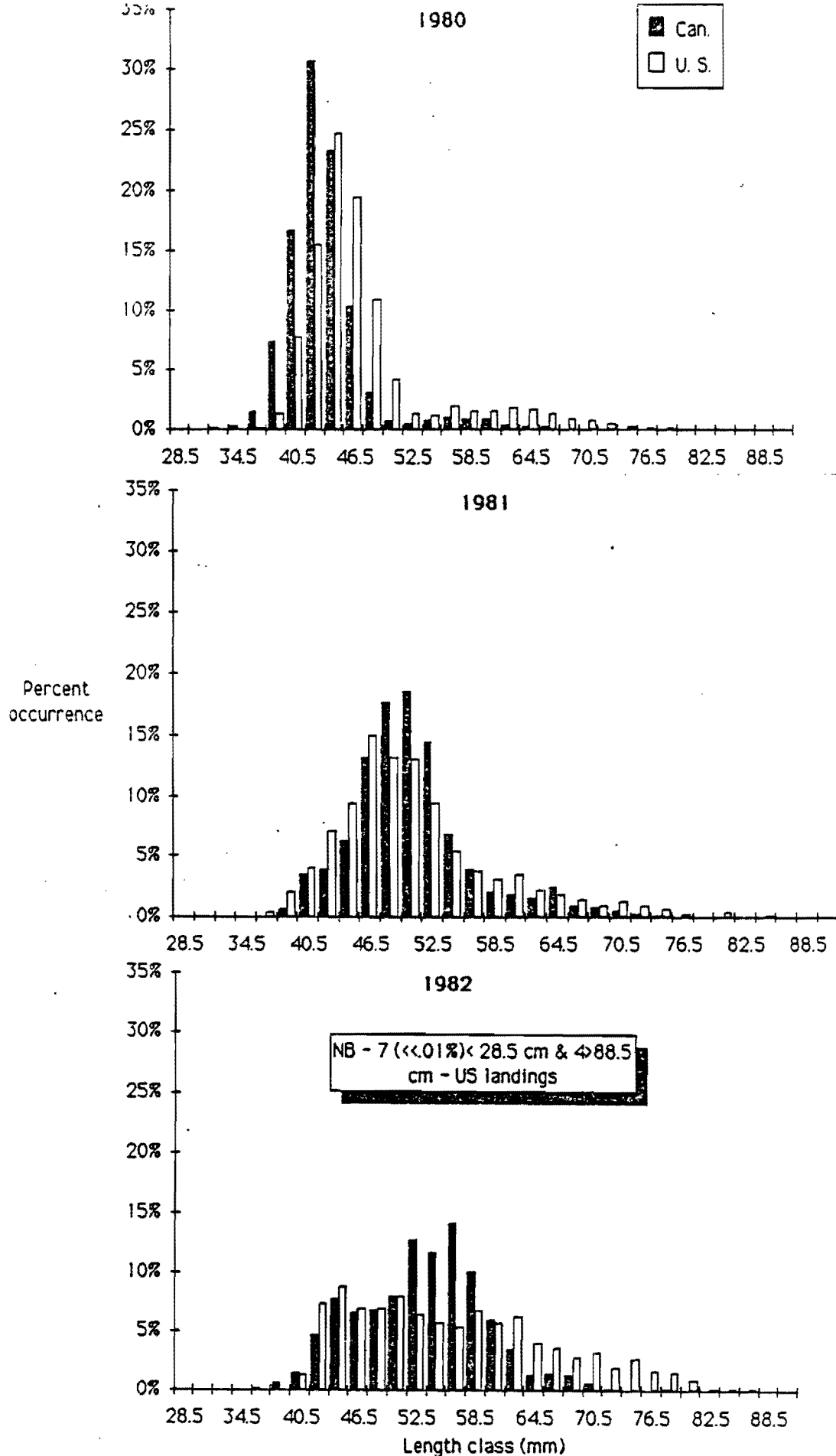


Fig. 8. Length-frequency distributions of Georges Bank haddock (3rd quarter only) caught by the Canadian (otter trawlers only) and United States (all gear types) fleets, 1980-1982.

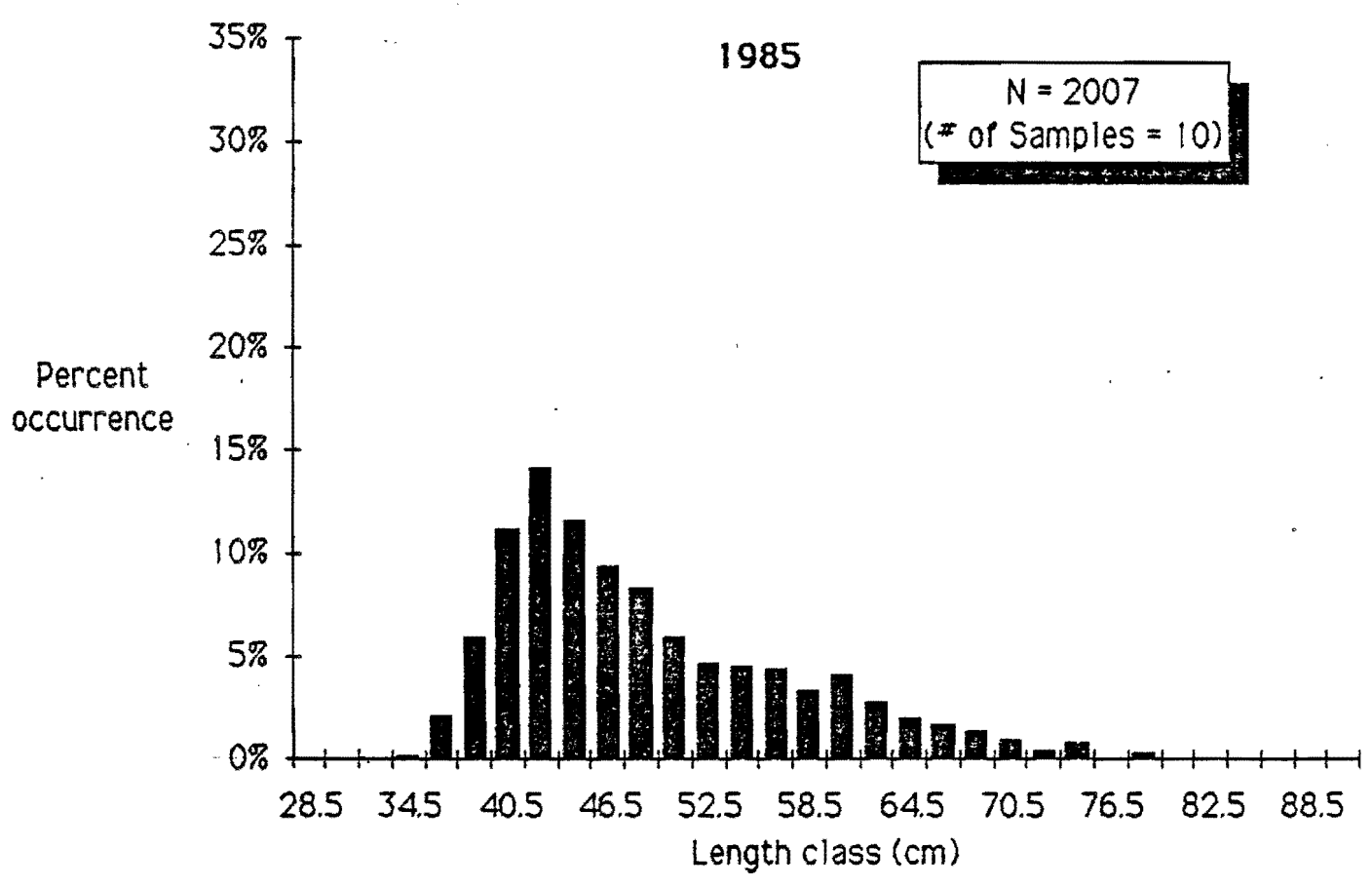


Fig. 9. Length-frequency distribution of 5Z haddock caught by Canadian otter trawlers in June and July, 1985.

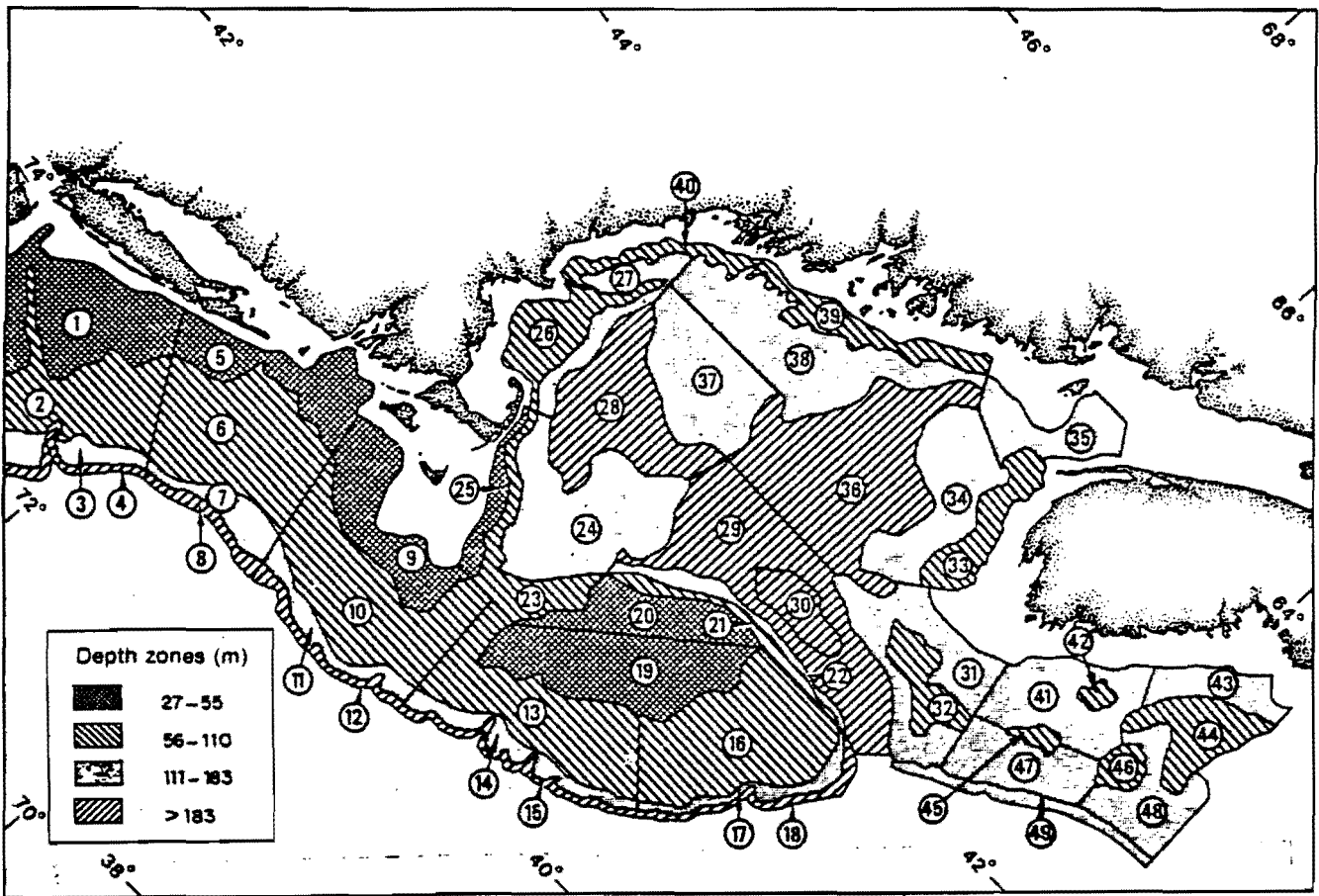


Figure. 10. Stratification scheme used for USA spring and autumn bottom-trawl surveys of Georges Bank and Gulf of Maine areas.

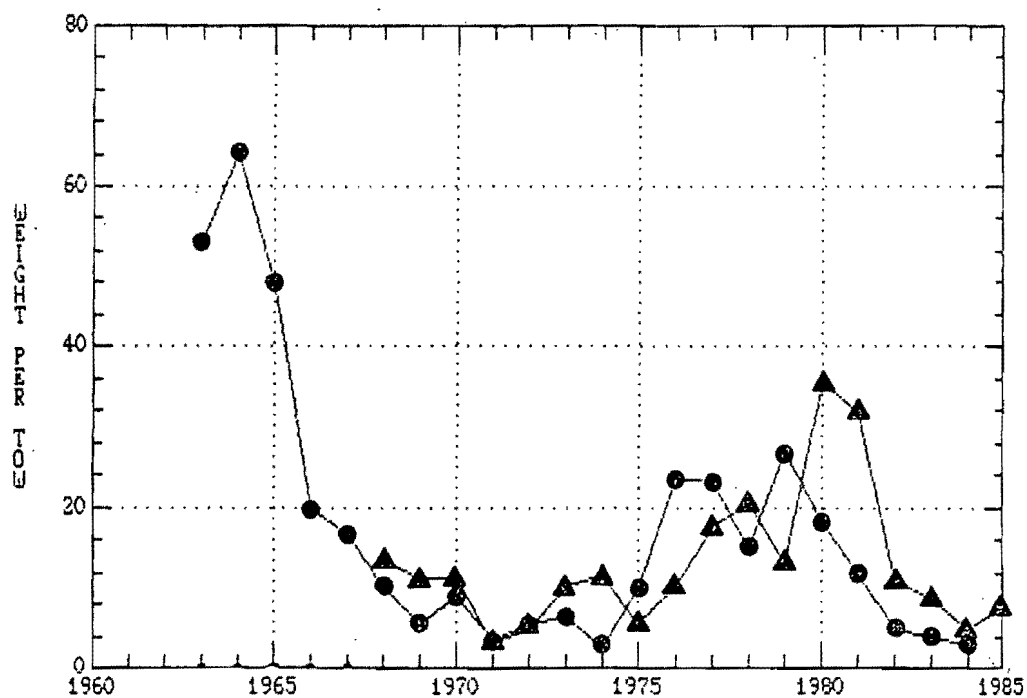
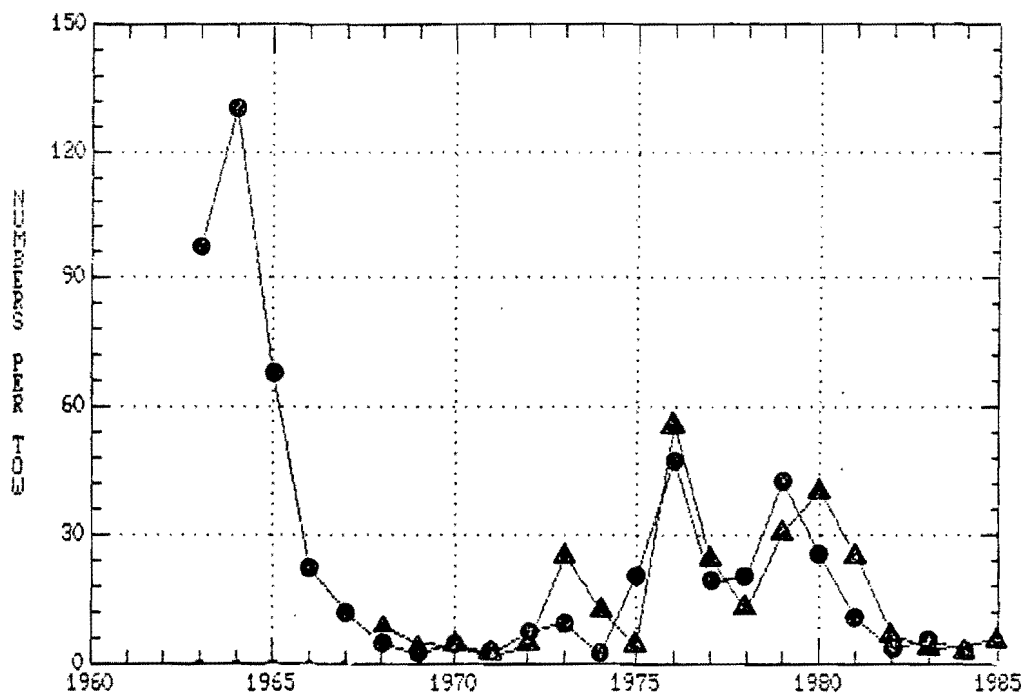


Fig. 11. Trends in stratified mean catch (number and weight) per tow of 5Z haddock caught during United States surveys conducted from 1963-85. The autumn survey series is denoted by (●), and the spring series by (▲). The data series were not smoothed.

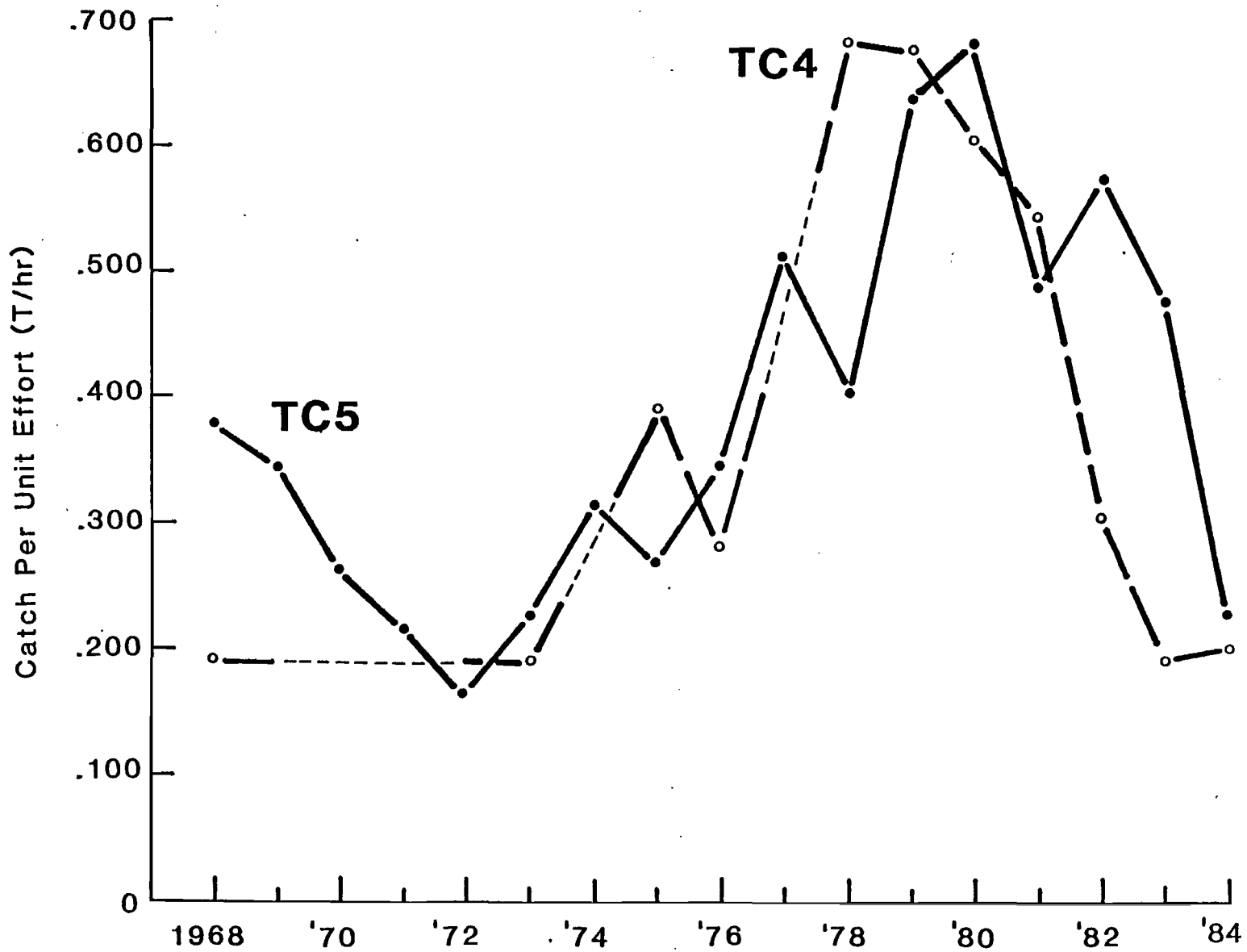


Fig. 12. Catch-per-unit-effort series for Tonnage Class 4 and 5 Canadian otter trawlers, 1968-1984. Series are for "main species" trips only (June-September).

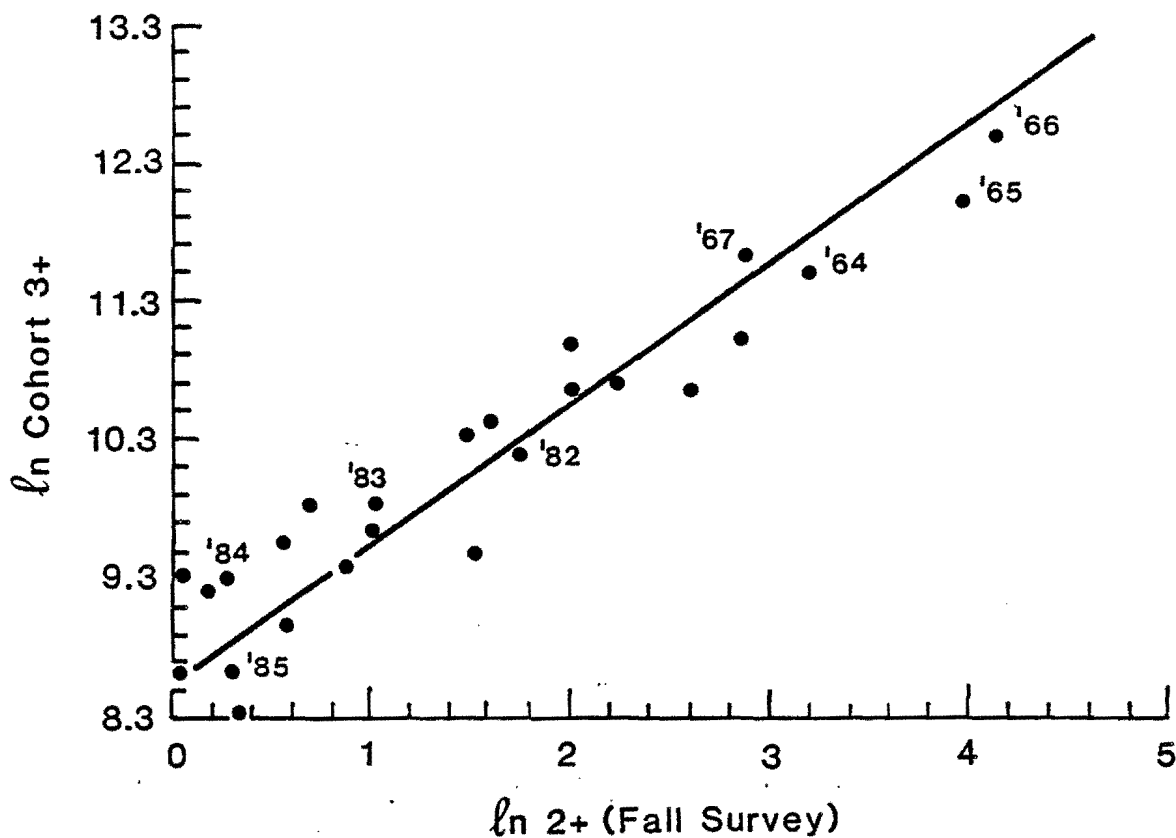


Fig. 13. Relationship of \ln 2+ fall survey numbers per tow (in year t) vs. \ln cohort 3+ numbers (year $t + 1$) calculated from cohort analysis with $F = 0.50$ on fully recruited ages. Line is constrained by a slope of 1. Numbers on figure denote year for cohort 3+ numbers. (see Table 20)

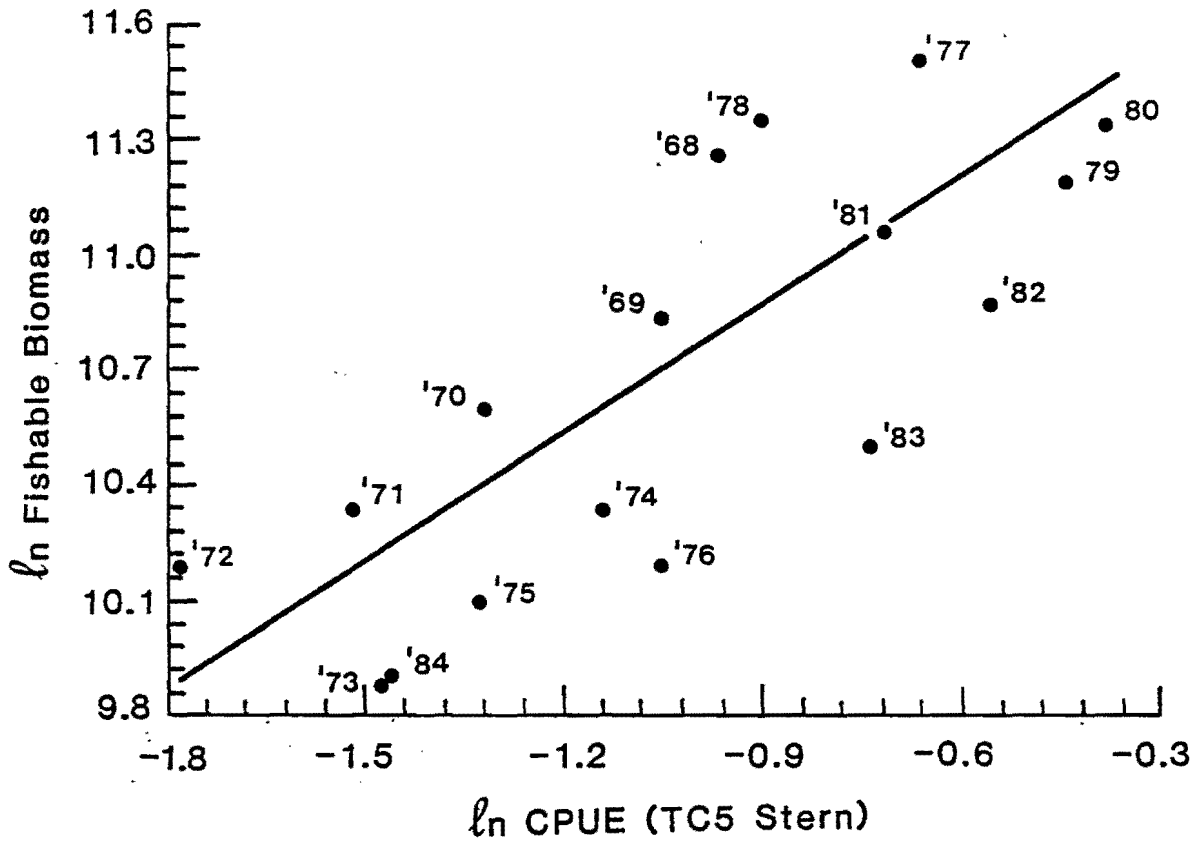


Fig. 14. Relationship of \ln CPUE for TC5 stern trawlers (+ 1 hr) vs. \ln fishable biomass calculated from cohort analysis with $F = 0.50$ on fully recruited ages. Line is constrained by a slope of 1.

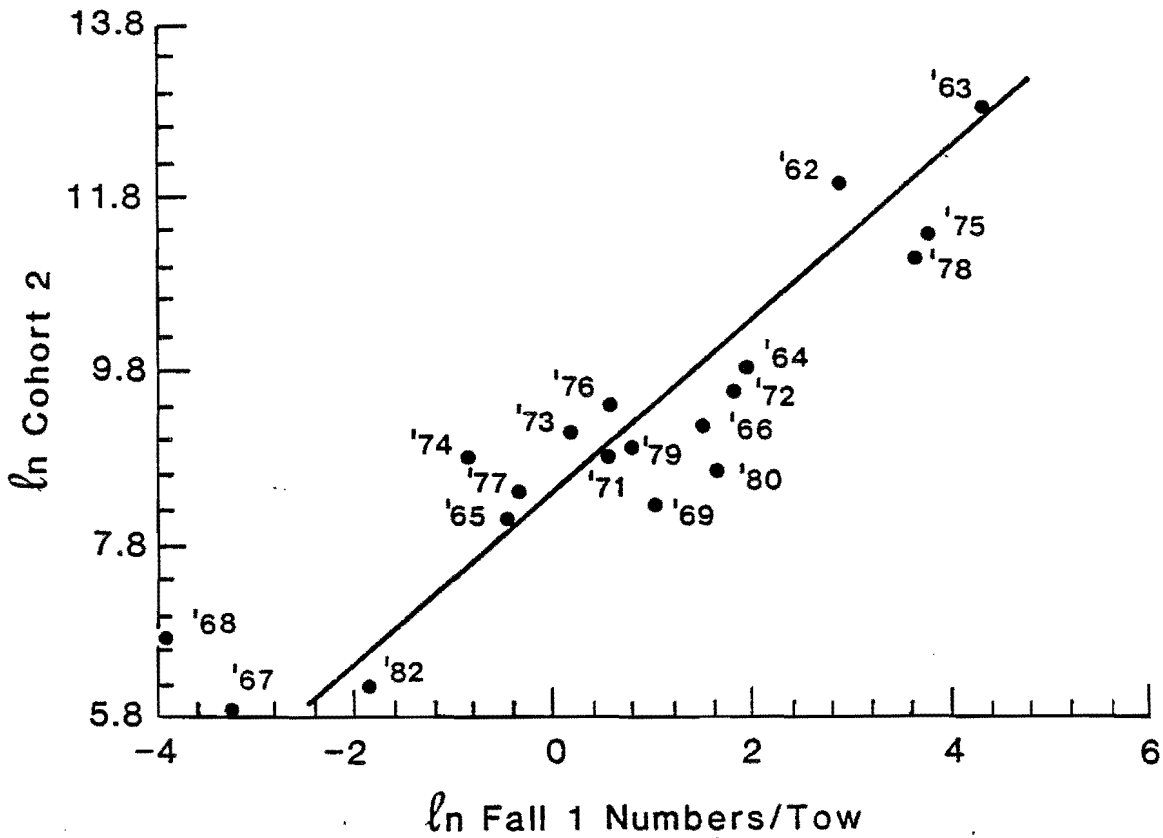


Fig. 15. Relationship between \ln fall survey age 1 numbers per tow vs. \ln cohort numbers at age 2 (lagged one year). The relationship is constrained by a slope of 1. Cohort numbers were calculated with $F = 0.50$ for fully recruited ages. Numbers in figure represent year-class (see also Table 22).

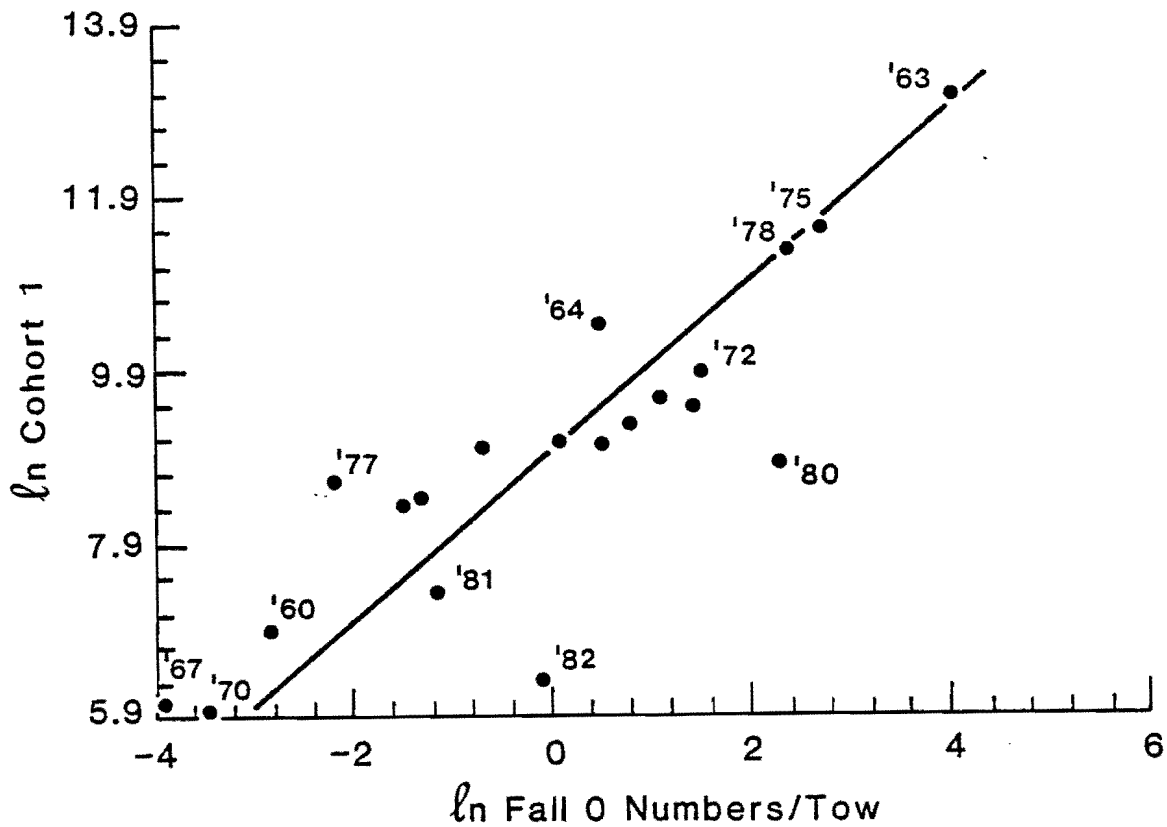


Fig. 16. Relationship between \ln fall survey 0 numbers per tow vs. \ln cohort numbers at age 1 (lagged one year). The relationship is constrained by a slope of 1. Cohort numbers were calculated with $F = 0.50$ for fully recruited ages. Numbers in figure represent year-class (see also Table 22).