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Current Assessment and Status of the  
Georges Bank and Gulf of Maine Cod Stocks

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by

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1. Introduction

Atlantic cod (Gadus morhua) fisheries off the Atlantic coast of the United States may be categorized into three major groupings: (1) Georges Bank; (2) Gulf of Maine; and (3) Southern New England-Middle Atlantic. Minimal interchange of cod occurs between the Georges Bank and Gulf of Maine groups, while intermingling between the Georges Bank and Southern New England-Middle Atlantic populations is extensive (Serchuk et al. 1978). Wise (1962) suggested that cod in the Middle Atlantic comprised a genetically distinct subpopulation; more recent analyses, however, indicate strong affinities between the southerly cod populations and those of Georges Bank (Serchuk and Wood 1979). Presently, US Atlantic coast cod fisheries are managed as two distinct stocks: (1) Gulf of Maine: FCZ north of  $42^{\circ}20'N$  latitude which is west of  $70^{\circ}00'$  longitude and is bounded on the south by the northern shore of Cape Cod; and (2) Georges Bank and Southward: FCZ other than the Gulf of Maine.

This report provides current assessment information on the Georges Bank and Southward, and Gulf of Maine Atlantic cod stocks. Reported commercial landings statistics and research survey bottom trawl data are updated through 1979 and results of the 1979 spring and autumn research vessel surveys are presented. Background information for both stocks has been previously summarized in Serchuk et al. 1977, 1978, 1978b, 1979, and NEFC 1978.

## 2. Results and Discussion

### 2.1 Georges Bank Stock

#### 2.11 Reported Landings Statistics

Provisional commercial landings in 1979 from the Georges Bank and South stock totaled 37,067 metric tons (mt) (Table 1). Reported USA commercial landings were 31,269 mt, an 18% increase from the 1978 reported catch of 26,579 mt, and the highest annual domestic catch since 1930. Provisional 1979 Canadian commercial catches were 5,798 mt, a 3,106 mt decrease from 1978 (-35%). Overall, total commercial landings in 1979 increased 4.5% from 1978 (35,483 mt).

Total removals from the Georges Bank and South cod stocks during 1979 were regulated under the Fishery Management Plan (FMP) for Atlantic Groundfish. An OY of 26,000 mt was established on 1 October 1978 to regulate the total commercial harvest (22,000 mt, US commercial; 4,000 mt, Canadian commercial) during the "fishing year" 1 October 1978-30 September 1979 (Table 2). The "fishing year" OY was subsequently amended, effective 22 July 1979, to be 34,960 mt (30,960 mt, US commercial; 4,000 mt, Canadian commercial) (Table 3). Reported US commercial landings during the 1978-1979 fishing year were 29,802 mt, 3.7% less than the allocated quota.

During October, 1, 1979 - December 31, 1979 (first quarter of 1979-1980 fishing year), the fishery was to be regulated under an annual fishing year OY of 26,000 mt (the same OY established for the 1978-79 fishing year); the first quarter US commercial allocation was to be 5,640 mt.

Prior to the start of the 1979-80 fishing year, however, the New England Regional Fishery Management Council (NEFFMC) submitted an amendment (Draft Amendment No. 4) to the FMP to the Secretary of Commerce proposing that the annual OY for the new fishing year be 35,000 mt (29,620 mt, US commercial; 5,380 mt Canadian commercial). Under provisions of this Amendment, the first quarter (Oct.-Dec. 1979) US commercial allocation was to be 7,595 mt (Tables 2 and 3). Although the Amendment has yet to be approved and implemented by the Secretary, landings during the first quarter were regulated by the OY and quarterly quota provisions of the Amendment, under the supposition that these proposed actions would subsequently be approved by the Secretary.

The resultant effective US commercial quota for calendar year 1979 was thus 32,915 mt (Table 3). Reported US commercial landings during 1979 (31,269) amounted to 95% of this allocation.

During 1979, US commercial vessel class and trip catch limitations were revised on five occasions (Table 2). No vessel class fishery closures, however, occurred during the calendar year. Nonetheless, unreported and misreported US commercial cod catches are believed to have been landed. Hence, similar to conditions in 1977 and 1978, the reported US commercial landings for 1979 are thought to under-

estimate the actual catch. As before, the degree of inaccuracy in the landings statistics is not presently quantifiable.

Total recreational landings of cod from the Georges Bank and South stock in 1979 are not known. Reported catches of cod during 1979 as derived from NMFS Recreational Groundfish logbook records submitted by charter and party boats totaled 116 mt, a 78% decrease from the 521 mt reported from charter and party boat logbook records in 1978. Since party and charter boat licenses and logbook records are only required of vessels fishing cod, haddock, and yellowtail flounder within the FCZ, the logbook data underestimate the actual catch of all party and charter boats that caught cod.

Prior to 1977, total recreational landings of cod from the Georges Bank and South stock were estimated from national and regional salt-water angler surveys (conducted in 1960, 1965, 1970, and 1974), and by deriving ratios between the recreational landings reported in the angler surveys and the corresponding yearly US reported commercial landings (Serchuk et al. 1977; Table 1). Subsequent to 1976, estimated annual total recreational cod harvests have not been derived because of the uncertainties associated with the domestic commercial catch statistics. Accurate commercial landings data are requisite for the recreational landings estimation procedure detailed in Serchuk et al. 1977.

#### 2.12 Commercial Catch Composition

Analysis of the market category distribution of the 1979 reported domestic commercial Georges Bank and South landings indicated that

"market cod" (2.5-10.0 lbs; 1.1-4.5 kg) comprised 55% of the catch by weight (Table 4). This percentage of the landings is similar to the 1978 "market" category percentage (60%) and reflects the continued dominance of the 1975 year class in the fishery. The increase in proportional representation of "large" cod (10.0-25.0 lbs; 4.5-11.3 kg) in the landings from 1978 to 1979 (29% to 37%) suggests that a portion of the 1975 year class may already have grown enough in weight to appear in the "large" category.

The percentage of "scrod" (1.5-2.5 lbs; 0.7-1.1 kg) in the 1979 catch declined slightly from 1978 (7% vs 11%). The 1979 percentage is one of the lowest observed in the recent time series and implies that the 1977 year class is relatively weak or that partial recruitment of this year class as scrod is significantly less than most of the other year classes.

## 2.13 Research Vessel Bottom Trawl Survey Indices

### 2.131 Total Stratified Mean Catch Per Tow

Linear mean catch per tow indices (numbers and weight) from both the autumn and spring 1979 bottom trawl surveys on Georges Bank (strata 13-25) declined from 1978 (Table 5). The autumn 1979 linear mean number per tow (4.82) was 31% lower than in 1978 (6.97), while the linear mean weight (lbs)per tow index in autumn 1979 was 33.5, 29% lower than the 1978 value (47.3). Declines between the spring 1978 and 1979 linear catch per tow values were more pronounced (numbers: 7.89 to 3.30 (-58%); weight: 42.5 to 23.0 (-46%)).

Between 1974 and 1978, the autumn linear mean catch per tow indices (both numbers and weight) generally increased annually implying concomitant increases in population size (Figures 1a and 2a). The 1979 values, although less than 1978, are still considerably above the average levels noted during 1963-1978 (number/tow: mean = 4.17; median = 3.17; weight/tow: mean = 21.2; median = 17.8). The spring indices have not shown as consistent a pattern as the autumn series. The 1979 spring linear mean catch per tow values were among the lowest since 1973 (spring surveys since 1973 have used a 41 Yankee trawl as standard sampling gear), while the preceding 1978 indices were among the highest. Rather than reflecting actual changes in relative abundance, the spring results are confounded by the tendency for South Channel cod to migrate southwesterly away from Georges Bank in late autumn - early winter. Generally, this migration occurs after October when the autumn survey has normally been completed. The return migration northward, however, is temporally more irregular in relation to the April-May spring bottom trawl surveys on Georges Bank. Hence, annual fluctuations in the spring mean catch per tow indices from Georges Bank (strata 13-25) may often result not from changes in total abundance but from yearly differences in the timing of the spring northeasterly return migration of the South Channel cod.

Examination of the frequency distributions of the number of cod caught per tow in both the autumn and spring bottom trawl surveys indicated that catches have approximated a negative binomial distribution. The standard deviation of the linear stratified mean catch per tow

is linearly related to the mean and generally exhibits a small positive y-intercept (Figures 3a and 4a), properties consistent with the hypothesis that the distribution is negative binomial (Pennington and Grosslein 1978). Accordingly, a  $\ln(x+1)$  transformation of the individual station catches (both in numbers and weight) was accomplished and  $\ln$  stratified mean catch per tow indices for Georges Bank cod were calculated for each autumn survey, 1963-1979 (Tables 6 and 7). A similar procedure was followed for the spring surveys but these data are not presented due to the difficulties in evaluating the results obtained during 1968-1972 with those obtained afterward because of differences in the sampling gear between the two periods.

The  $\ln(x+1)$  transformation tended to stabilize the variances of the autumn number and weight per tow data as demonstrated by the lack of significance ( $P > 0.05$ ) of the regression coefficients (number per tow:  $b = 0.053$ ; weight per tow:  $b = -0.017$ ) from zero for the transformed data sets (Figures 3b and 4b). Normal parametric methods were subsequently utilized to generate confidence intervals and evaluate the precision of each of the yearly stratified mean catch per tow estimates (Tables 6 and 7). Retransformation of the  $\ln$  indices to the original linear scale was accomplished using the equation given by Finney (1941):

$$\bar{y} = \exp(\bar{x} + S^2/2) - 1,$$

where  $\bar{y}$  = estimated retransformed stratified mean catch per tow,  $\bar{x}$  =  $\ln(x+1)$  stratified mean catch per tow and  $S^2$  = estimated population variance ( $\ln$  scale).

Temporal trends in the ln and retransformed stratified mean catch per tow indices are nearly identical to the trends in the linear number and weight per tow values (Figures 1 and 2). Similar to the linear 1979 catch per tow indices, the 1979 ln and retransformed values were less than those in 1978 but above the 1963-1978 average. The associated confidence intervals for the 1979 ln and retransformed indices suggest that the current relative abundance level is not statistically different from the 1978 level.

Precision of the stratified estimates can be evaluated by examination of the relative standard errors (ratio of standard deviation to the mean). The standard error of the linear number per tow indices during 1963-1979 averaged 0.24, while the corresponding average of the ln number per tow standard errors was 0.14, or 42% less. For the stratified mean weight per tow linear and ln indices, the average standard errors were 0.24 and 0.13, respectively. On an absolute basis, these data imply that for the survey time series, proportional annual changes in abundance less than +50% of the mean catch per tow index (numbers or weight) could not be detected with high probability on a linear scale, and that when using the transformed scale, differences in mean number per tow less than +25% and in weight per tow less than +45% (both relative to proportional changes on a linear scale) were not normally detectable.

Sampling intensity in autumn 1979 was approximately equal to that in 1978 (145 vs 156 tows) while the spring 1979 survey sampling intensity was about 61% greater than in 1978 (Table 8). Since 1977, the relative standard errors (RSEs) of the autumn catch per tow estimates (both numbers

and weight: ln scale) have been significantly lower than previous autumn survey RSEs (Tables 6 and 7); the average RSEs during 1977-1979 were 0.09 (ln numbers) and 0.07 (ln weight) compared to the 1963-1976 average RSEs of 0.15 and 0.14, respectively. Hence, increases in precision of 40% (ln numbers) and 50% (ln weight) are indicated. These increases are primarily attributable to the increased autumn sampling intensity of recent years (the mean number of tows in the Georges Bank survey during 1977-1979 was 150; between 1963-1976, the surveys averaged 69 tows per cruise). According to simple random (but non-stratified) sampling theory, the increased level of sampling intensity in the most recent years should have resulted in a 32% increase in the precision of the mean catch per tow estimates, viz.

$$[(S.D./\sqrt{69} - S.D./\sqrt{150}) / (S.D./\sqrt{69})] \times 100 = 32\%$$

The actual observed increases in precision are slightly larger than expected from the simple theory because, in a stratified random survey, increases in precision are also affected by the relative sampling effort within strata and the variance of the mean catch per tow among strata.

### 2.132 Stratified Mean Number Per Tow By Age Group

Stratified mean catch per tow values in numbers at age for Georges Bank are given in Tables 9 and 10. The autumn 1979 survey age samples are currently being analyzed and hence age composition data for this cruise could not be included in Table 9. Values listed in the table for age 0 and age 1 were estimated from length-frequency distributions of the stratified mean number per tow caught by 3-cm length group. The 1976 and 1978 autumn catch at age data have been slightly revised from those listed previously (Serchuk et al 1979: Table 6) due to the availability of finalized age-length keys from these surveys.

The autumn 1979 catch per tow index of age 0 cod (1979 year class) was 0.096, the second lowest age 0 value since 1970, and suggests that the 1979 year class is relatively poor in strength (Table 9). The spring 1979 age 0 catch per tow index was 0.070 (Table 10). Evaluation of relative year class abundance from the spring age 0 value is difficult, however, since cod spawning is usually still transpiring at the time of the spring cruises. Hence, the spring age 0 index has historically not been reflective of year class strength.

The stratified mean number per tow of age 1 cod (1978 year class) in the autumn 1979 survey (1.210) was slightly above the median age 1 survey index from 1970-1978 (1.082) implying that the 1978 year class may be slightly better than average. This evaluation of relative year class strength is thus similar to that deduced from the autumn 1978 age 0 index for the 1978 year class. The spring 1979 age 1 catch per tow estimate was 0.278.

Compared to previous age 1 spring values from 1973-1978 (all obtained with the "41 Yankee trawl"), the 1979 index is slightly higher than the median, thereby supporting the inference that the 1978 year class is slightly above average in strength.

The 1979 spring survey age composition data show that the 1975 year class comprised 37% of the population by number (1.229/3.304) (Table 10) and hence this year class remains the dominant one. In 1978, the 1975 year class comprised 49% of the total autumn stratified mean catch per tow and 45% of the total 1978 spring number per tow value.

Spring 1979 survey catch per tow indices for the 1977 (age 2) and 1976 (age 3) year classes were below average in relation to previous (1973-1978) age 2 and 3 spring values; the 1978 age 2 index was below the median while the age 3 index was the lowest observed. Accordingly, these year classes will probably not be highly significant in the fishery.

#### 2.14 Relative Exploitation Rates

Mean annual relative exploitation rates were derived for 1964-1979 by dividing total reported landings (commercial, and commercial and recreational) by the autumn survey weight per tow index (Table 11). To establish a smooth time series of catch and survey values for elucidation of general trends, 3-year averages were calculated ( $\bar{x} \text{ year}_i = \Sigma ((\text{year}_{i-1} + \text{year}_i + \text{year}_{i+1})/3))$ ). Inclusion of the survey index from year  $i+1$  in the derivation of the average for survey year  $i$  facilitated better correspondence between the yearly catch and survey indices since commercial landings of recruiting fish ( $\leq$  age 2), in any year, are generally not proportionally represented in the autumn survey weight per tow index until the following year.

Relative exploitation rates during 1971-1976 were substantially less than during 1964-1970 (31% lower for "A/C", and 54% lower for "B/C" ratios - Table 11).

Assuming fishing mortality is proportional to the relative exploitation rate, these differences imply that significant reductions in fishing mortality occurred during the early 1970's.

Since 1977, annual relative exploitation rates have stabilized at about 0.90, 20% less than the 1971-1976 average (1.12). The 1977-1979 indices, however, probably underestimate the relative exploitation rates since the reported landings were used in deriving these values. As previously noted (section 2.11), the actual cod catch in these years may have been much higher. Nevertheless, even if the annual reported US commercial landings in 1977-1979 were doubled, the resultant relative exploitation rates (1.35, 1.68, and 1.61, respectively, using the averaging techniques cited in Table 11) would still be about 40% less than the 1964-1970 average relative exploitation rate (2.60). If the reported US landings since 1977 underestimate the actual catch by only half, the average relative exploitation rate for 1977-1979 (1.22) would only be 9% higher than the 1971-1976 average.

#### 2.15 Implications of the Current Georges Bank Assessment

Results of the present assessment analyses indicate that the Georges Bank and South cod stock biomass has remained at a relatively high level during 1979. The 1979 autumn survey catch per tow indices were considerably above the 1963-1978 average levels; the 1979 stratified mean weight per tow estimates (linear, ln, and retransformed) were among the highest in the autumn bottom trawl series. None of the 1979 catch per tow values were significantly different from the relatively high 1978 indices. Recruitment of the 1978 year class as evinced by the 1979 autumn

and spring age 1 catch per tow indices appears to be slightly better than average. The 1979 year class, however, seems to be a relatively poor one, based on the autumn 1979 age 0 mean catch per tow.

The 1975 year class continues to be dominant in both the population and in the fishery. The spring 1979 age composition data indicate that this year class comprised 37% of the population, by number; the 1979 market category commercial catch composition indicated that "market cod" (mostly cod of a body weight that would correspond with that expected from the 1975 year class) accounted for 55% of the catch by weight.

Relative exploitation rates since 1977 appear to have stabilized at the lowest levels observed in the 1964-1979 time series. Even if the reported US commercial landings statistics underestimate the actual catch in recent years, relative exploitation rates derived by assuming that the US catch was 50% and 100% greater than reported would still be lower than about half of the annual exploitation rates observed during 1964-1976.

The present assessment of the status of the Georges Bank and South cod stocks has been largely based on bottom trawl survey data due to analytical limitations imposed by uncertainties in the US commercial landings statistics. Since 1977, the precision of the autumn survey catch per tow estimates has improved by greater than 40% from that observed during the 1963-1976 period. This improvement has resulted from increased sampling intensity in recent years.

## 2.2 Gulf of Maine Stock

### 2.21 Reported Landings Statistics

Provisional 1979 reported commercial landings of Gulf of Maine cod totaled 11,739 mt (Table 12), an 8.4% decrease from the record-high 1978 reported catch of 12,810 mt. US reported landings accounted for 97% (11,424 mt) of the 1979 total; the remaining 3% (315 mt) was taken by Canada.

Total removals from the Gulf of Maine cod stock during 1979 were regulated under the Atlantic Groundfish FMP. An OY of 8,500 mt was established on 1 October 1978 to regulate the total harvest (6,000 mt, US commercial; 2,500 mt, recreational for FCZ charter and head boats) during the "fishing year" 1 October 1978 - 30 September 1979 (Table 13). On July 22, 1979, the "fishing year" OY was subsequently amended to be 11,380 mt (8,800 mt, US commercial; 2,500 mt, recreational for FCZ charter and head boats) (Table 3). Reported US commercial landings during the 1978-79 fishing year were 11,368 mt, 29% more than the US commercial allocation and 1% less than the total OY.

During October 1 - December 31, 1979, (first quarter of 1979-1980 fishing year), the Gulf of Maine fishery was to be regulated under an annual fishing year OY of 8,500 mt (the same level established for the 1978-79 fishing year); the first quarter US commercial allocation was to be 1,420 mt. Prior to the initiation of the 1979-80 fishing year, however, the NERFMC submitted an amendment to the FMP (Draft Amendment No. 4) to the Secretary of Commerce proposing that the annual 1979-80 OY be 12,000 mt (9,500 mt, US commercial; 2,500 mt, recreational for FCZ charter and head boats) (Table 13). Under provisions of this Amendment, the first quarter (Oct. - Dec. 1979) US commercial allocation was to be 2,250 mt (Tables 3 and 13). Although this

Amendment has still not been approved or implemented by the Secretary, US commercial landings during this first quarter were regulated by the OY and quarterly quota provisions of the Amendment under the supposition that these proposed actions would subsequently be approved by the Secretary.

The resultant effective US commercial allocation for calendar year 1979 was therefore 9,710 mt (Table 3). Reported US commercial landings during 1979 (11,474 mt) amounted to 118% of this allocation.

During 1979, the Gulf of Maine fishery was closed on three occasions (Table 13). The entire commercial directed cod fishery was closed from 22 July 1979 - 30 September 1979. Additionally, US commercial vessel class and trip catch limitations were revised six times. As a result, in part, of the changing management regimen, US reported commercial landings are believed to underestimate the actual catch due to unreported and misreported catch. The extent of inaccuracy in the landings statistics is currently unknown.

Total 1979 recreational landings from the Gulf of Maine cod stock could not be estimated as previously done during 1960-1976 (Table 12) due to the absence of accurate commercial catch information (see Section 2.11). The FMP (as amended) included a 2,500 mt recreational allocation for the charter and party boat fishery. During 1979, NMFS Recreational Groundfish Logbook records, submitted by licensed charter and party boats operating in the Gulf of Maine, indicated a total cod catch of 307 mt, a 47% decrease from the 1978 reported charter and party boat landings of 581 mt. As was true for the reported Georges Bank recreational data, the Gulf of Maine recreational logbook data underestimate total recreational landings due to incomplete

compliance with the logbook record keeping requirements and incomplete knowledge of landings within the territorial seas (Nicholson and Ruais 1979).

## 2.22 Commercial Catch Composition

Market category distribution of the reported 1979 commercial US Gulf of Maine cod landings indicated that "scrod" cod comprised 11% of the catch (by weight), "market" cod, 49%, and "large" cod, 38% (Table 4). The 1979 commercial catch composition is thus similar to the 1978 distribution; in both years, "market" cod dominated the landings. These patterns continue to reflect the dominance in the fishery of the strong 1971 year class ("large" cod) and the moderately strong 1973 and 1974 year classes ("market" cod).

The percentage of "scrod" in the 1979 catch declined by 35% from 1978 (17% vs 11%) and was the lowest level observed since 1973. This decline was expected (Serchuk et al 1979: p. 11) due to the relatively weak 1976 year class remaining in the "scrod" category. In 1980, "scrod" landings are expected to significantly increase due to recruitment of the relatively strong 1977 year class (see Section 2.232) into the fishery as "scrod".

## 2.23 Research Vessel Bottom Trawl Survey Indices

### 2.231 Total Stratified Mean Catch Per Tow

Autum 1979 bottom trawl survey linear mean catch per tow estimates, both in numbers and weight, declined from 1979 (Table 5). The stratified linear mean number per tow in 1979 was 2.23, 52% less than the 1978 index of 4.66; stratified linear mean weight (lbs) per tow (23.8) in 1979 was 9% less than in 1978 (26.2). The 1979 mean number per tow index was statistically significantly different ( $P < 0.05$ ) from the 1978

value (Table 14; Figure 5A), and was below the 1963-1978 average (mean: 2.99; median: 2.80), although not statistically different from this average. The 1979 weight per tow index, however, was the fifth highest in the autumn survey series and was not significantly different from either of the relatively high 1977 or 1978 indices (Table 15; Figure 6A). These latter results imply that Gulf of Maine cod stock biomass in 1979 has remained at the relatively high levels observed during the previous two years.

The 1979 spring linear catch per tow indices (Table 5) were higher than in 1978. Stratified mean number per tow was 109% higher (1.31 in 1978 vs. 2.74 in 1979), while the stratified mean weight per tow index was 23% higher (10.5 in 1978 vs 12.9 in 1979). Both estimates were the second highest since 1973, when the "41 Yankee" trawl became the standard sampling gear in the spring surveys.

Similar to the Georges Bank autumn bottom trawl survey frequency distributions of cod catch per tow, the autumn survey Gulf of Maine cod catches have also approximated negative binomial distributions. The standard deviations of both the linear stratified mean number and weight per tow estimates are linearly related to the mean (Figures 7a and 8a). To stabilize variance, a  $\ln(x+1)$  transformation of the station catches (for numbers and weight) was made. The resulting  $\ln$  stratified mean catch per tow indices are presented in Tables 14 and 15. An identical transformation was accomplished for the spring survey catch data (Tables 16 and 17). The spring data have not been summarized graphically, however, due to difficulties in evaluating the time series from 1968-1979 because

of the difference in sampling gear between 1968-1972 and 1973-1979,

The regression coefficients derived by linearly regressing the ln standard deviation against the ln mean catch per tow (number per tow:  $b = -0.014$ ; weight per tow:  $b = -0.031$ ) were not significantly different from zero ( $P > 0.05$ ) implying that the transformation procedure resulted in stabilization of variance (Figures 7b and 8b). Accordingly, normal parametric procedures were used to derive confidence limits and evaluate the precision of the annual autumn ln mean catch per tow estimates (Tables 14 and 15). Retransformation of the ln indices to the original linear scale was accomplished as described in Section 2.131; these values are plotted in Figures 5c and 6c.

Temporal trends in the ln and retransformed stratified mean catch per tow values are virtually identical to the corresponding time series fluctuations in the linear number and weight per tow indices (Figures 5 and 6). The 1979 ln and retransformed weight per tow estimates were not significantly different ( $P > 0.05$ ) from the 1977 or 1978 values and thus corroborate the inference derived from the linear comparisons (i.e., no significant change in relative stock biomass in 1979 from the preceding two years). The 1979 retransformed number per tow index, like the linear index, was significantly different from the 1978 value but the ln index was not (Figure 5; Table 14). None of the spring 1979 catch per tow estimates (linear, ln, and retransformed: numbers and weight) were significantly different from their respective 1978 values ( $P > 0.05$ : Tables 16 and 17).

Precision of the stratified linear and ln estimates was evaluated from the associated relative standard errors (RSEs: standard deviation/mean). During 1963-1976 (when autumn sampling intensity averaged 54 tows/year), the average RSEs for the linear number and weight per tow indices were identical (0.29); the average RSEs for both of the ln indices were also equal but were 45% less than the linear RSEs (0.16) (Tables 14 and 15), implying significant improvement in precision using the ln scale (i.e., differences in annual mean catch per estimates of +32% were detectable in the ln scale while linear differences less than +58% were not). On an absolute basis (absolute size of standard deviation rather than relative size), however, +2 standard deviations on the ln scale, corresponds to +52% on the linear scale. Hence, little improvement is gained in detecting proportional annual changes in the mean estimates on the ln scale as compared with the non-transformed scale, other than the ln estimates are more efficient estimates of differences and that the estimated confidence limits more closely approximate true 95% confidence intervals (Grosslein 1971).

Examination of the RSEs during 1977-1979 (numbers and weight: linear and ln) (Tables 14 and 15) indicates that recent levels of precision have sharply improved from those noted during 1963-1976. The average RSEs during 1977-1979 were 0.15 and 0.14 for linear numbers and weight, respectively, and 0.10 for both ln numbers and weight. Compared to the 1963-1976 average RSEs, increases in precision of about 50% (linear) and 38% (ln) in recent years are indicated. Similar to Georges Bank,

these increases have primarily resulted from recent increases in autumn survey sampling intensity; during 1978-1979, the mean number of tows in the Gulf of Maine was 125, approximately 2.3 times greater than the 1963-1976 average (54 tows). According to simple random (but non-stratified) sampling theory, this increased sampling intensity should have been accompanied by a 34% increase in the precision of the mean catch per tow estimates, viz.

$$[(S.D./\sqrt{54} - S.D./\sqrt{125})/(S.D./\sqrt{54})] \times 100 = 34\%$$

The actual observed increases in precision are slightly larger than expected from simple theory because, in a stratified random survey, precision is also affected by relative sampling allocations within strata and the variance of the mean catch per tow among strata.

#### 2.252 Stratified Mean Number Per Tow By Age Group

Stratified mean catch per tow values (mean number per tow by age group) from the autumn and spring Gulf of Maine surveys, 1970-1979, are listed in Tables 9 and 10. Age samples from the autumn 1979 survey are currently being processed and therefore these data could not be included in Table 9. The values listed for age 0 and age 1 in Table 9

were estimated from a frequency distribution of the stratified mean number of cod caught per tow by 3-cm length category. The 1976 and 1978 autumn survey catch at age data have been slightly revised from previous tabulations (Serchuk et al 1979: Table 6) due to the availability of finalized age-length keys from these surveys.

No age 0 cod were caught in the autumn 1979 survey (Table 9).

Normally, better than average year classes have been apparent as age 0 fish in the autumn survey catches as evinced by relatively high age 0 indices for the 1971, 1973, and 1974 year classes. However, exceptions to this rule have occurred; the most recent example is the 1977 year class which did not appear in the 1977 survey as age 0 fish (index = 0.00) but has appeared in subsequent autumn and spring survey age 1 and age 2 indices as a fairly strong year class. The spring 1979 age 0 catch per tow index was 0.028 (Table 10). Although this is the highest age 0 value in the spring survey series, the spring index has historically not been indicative of relative year class strength since spawning is generally still underway during the spring trawl surveys. Consequently, the 1979 year class strength is difficult to currently evaluate from either survey index. Based on the more regular autumn results, the 1979 year class has been tentatively regarded as less than average in strength.

The stratified mean number per tow of age 1 cod (1978 year class) in the autumn 1979 survey (0.097) was the third lowest age 1 index in the autumn series, and was well below the average age 1 index from 1970-1978 (mean: 0.734; median: 0.210). Contrariwise, the spring 1979 age 1 catch per tow estimate (0.343) is the highest age 1 value ever observed in the spring bottom trawl series. Since both

autumn and spring age 1 catches tend to be consistent with relative year class strength patterns as subsequently reflected in age 2 and age 3 survey indices, the present disparity between the autumn and spring age 1 survey results is difficult to resolve. Hence, it may be prudent to consider the 1978 year class as average in strength until further data indicate otherwise.

The 1979 spring survey age composition data show that the 1977 year class (age 2) comprised 38% of the population by number (1.045/2.740) (Table 10) and is the dominant year class in the population. The age 2 survey index (1.045) is the second highest in the spring time series being surpassed only by the age 2 value in 1973 (i.e., the strong 1971 year class). A similar correspondence between the 1977 and 1971 year classes is evident in the 1978 and 1972 autumn survey age 1 indices (2nd highest and highest indices in the autumn time series). Accordingly, the 1977 year class may be the strongest in the fishery since the 1971 year class. Since the 1977 year class will recruit as "scrod" in 1980, the percentage of scrod in the 1980 market category catch composition should significantly increase from the 1979 level.

The moderately strong 1973 and 1974 year classes (age 6 and 5, respectively, in the spring 1979 survey) together comprised 25% of the total spring mean number per index (Table 10). Clearly, these year classes remain important in both the population and the fishery.

## 2.24 Relative Exploitation Rates

Mean annual relative exploitation rates were derived for 1964-1979 by dividing total reported landings (commercial, and commercial and recreational) by the autumn survey weight per tow index (Table 11). Details and rationale for this procedure have been previously discussed (Section 2.14).

Annual relative exploitation rates for Gulf of Maine cod can be grouped into three periods: (1) 1966-1971 during which exploitation rates were relatively stable reflecting stabilization of both annual landings and population biomass (survey weight per tow index); (2) 1972-1975 during which relative exploitation rates (and hence relative fishing mortality) increased annually (~100% increase between 1972 and 1975 values) as a consequence of increased yearly catches and sequential annual reductions in biomass; and (3) 1976-1979 during which exploitation rates have trended downward while autumn survey weight per tow values have generally risen upward (Table 11).

Since 1977, annual relative exploitation rates have stabilized about 0.55 ("D/F" ratio - Table 11), 30% lower than the high 1975-1976 average (0.79) but still considerably higher than the 1966-1971 mean relative exploitation rate (0.34). The production of the strong 1971 year class, and the moderately strong 1973 and 1974 year classes have had a pronounced effect in the recent increases in the Gulf of Maine stock biomass. The 1977 year class should equally be of significance during the next several years when it becomes fully recruited into the fishery.

The 1977-1979 derived relative exploitation rates probably underestimate the actual relative exploitation rates since reported US commercial landings during these years probably underestimate the actual catches. If unreported catches of 5,000 mt occurred in each of the last three years (i.e., if actual US commercial catch was about 41% higher than reported), the resultant annual relative exploitation rates (0.81 for 1977; 0.74 for 1978; and 0.69 for 1979) would approximate the highest observed (0.82 in 1975; 0.76 in 1976 - Table 11).

#### 2.25 Implications of Current Gulf of Maine Assessment

Results of the present assessment indicate that the Gulf of Maine cod stock biomass has remained during 1979 at the relatively high levels noted during 1977-1978. The 1979 autumn weight per tow indices (linear, ln, and retransformed) were among the highest in the survey series (Figure 6). The spring 1979 catch per tow indices (number and weight) were the second highest since 1973, when the "41 Yankee" trawl became the standard sampling gear for the spring surveys (Table 17).

Both autumn and spring catch per tow by age group data indicate that the 1977 year class is reasonably strong, and may be the strongest year class since the 1971 cohort. These data also imply that the moderately strong 1973 and 1974 year classes still comprise a significant component of the Gulf of Maine stock (i.e., 25% of the 1979 spring linear number per tow). The 1979 US commercial catch composition tends to corroborate the importance of these year classes to the fishery.

Disparities in the age 0 and age 1 indices between the autumn and spring 1979 surveys hinder precise evaluation of the relative strength of the 1979 and 1978 year classes. Tentatively, the 1979 year class is regarded as less than average in strength while the 1978 year class is considered average in size.

Since 1975, relative exploitation rates have decreased annually implying sequential annual reductions in fishing mortality. Due to uncertainties in the 1977-1979 US commercial landings statistics, however, the most recent relative exploitation rates may be higher than calculated. If unreported domestic commercial catches of 5,000 mt occurred during each of the past three years, the respective exploitation rates would be near the highest levels ever observed.

Overall, the autumn and spring 1979 survey weight per tow indices indicate that recent annual harvests (~12,000 mt per year) have not resulted in statistically detectable biomass changes. The precision of the 1978 and 1979 autumn survey catch per tow indices (ln scale) improved by 38% from the level of precision observed during the 1963-1977 survey period, largely as a result of a doubling in the annual autumn Gulf of Maine sampling intensity.

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Table 1. Atlantic cod landings (metric tons, live) from Georges Bank and southward (ICNAF Div. 5Z - SA6), by country, 1960-1979.

	Country									Total commercial	USA recreational	Grand Total
	USA				Canada	USSR	Spain	Poland	Other			
	5Z	5NK	6	Total								
1960	10,391	443	-	10,834	19	-	-	-	-	10,853	11,395 <sup>1</sup>	22,248
1961	13,998	455	-	14,453	223	55	-	-	-	14,731	14,838	29,569
1962	15,232	405	-	15,637	2,404	5,302	-	143	-	23,486	16,146	39,632
1963	13,904	235	-	14,139	7,832	5,217	-	-	-	27,189	13,487	40,676
1964	12,325	-	-	12,325	7,108	5,428	18	48	238	25,165	11,955	37,120
1965	11,410	-	-	11,410	10,598	14,415	59	1,851	-	38,333	11,029 <sup>1</sup>	49,362
1966	11,794	-	196	11,990	15,601	16,830	8,375	269	69	53,134	11,440	64,574
1967	12,742	-	415	13,157	8,232	511	14,730	-	122	36,752	12,360	49,112
1968	14,967	-	312	15,279	9,127	1,459	14,622	2,611	38	43,136	13,620	56,756
1969	16,356	-	426	16,782	5,997	646	13,597	798	119	37,939	14,884 <sup>1</sup>	52,823
1970	14,535	-	364	14,899	2,583	364	6,874	784	148	25,652	13,246 <sup>1</sup>	38,898
1971	15,795	-	383	16,178	2,979	1,270	7,460	256	36	28,179	14,393	42,572
1972	13,140	-	266	13,406	2,545	1,878	6,704	271	255	25,059	11,957	37,016
1973	15,933	-	269	16,202	3,220	2,977	5,980	430	114	28,923	8,922	37,845
1974	17,870	-	507	18,377	1,374	476	6,370	566	168	27,331	10,055 <sup>1</sup>	37,386
1975	15,240	349	428	16,017	1,847	2,403	4,044	481	216	25,008	8,534	33,542
1976	14,220	272	414	14,906	2,328	933	1,633	90	36	19,926	8,115	28,041
1977 <sup>2</sup>	20,355	467	316	21,138 <sup>3</sup>	6,173	54	2	-	-	27,367	-	27,367 <sup>4</sup>
1978 <sup>2</sup>	25,430	885	264	26,579 <sup>3</sup>	8,904	-	-	-	-	35,483	-	35,483 <sup>4</sup>
1979 <sup>2</sup>	31,269	-	-	31,269 <sup>3</sup>	5,798	-	-	-	-	37,067	-	37,067 <sup>4</sup>

<sup>1</sup>From angler surveys; remaining years estimated.

<sup>2</sup>Provisional.

<sup>3</sup>Reported USA landings are believed to underestimate actual commercial catch due to unreported catch and discards.

<sup>4</sup>Does not include recreational landings.

<sup>5</sup>Estimated.

Source: ICNAF Statistical Bulletins 1960-1977.

ICNAF Summary Document 79/V1/30 (Revised January 1980).

NNFS Fisheries Management and Statistics Branch (1979 USA landings).

Table 2. Fishery management actions in the Georges Bank and South Atlantic cod fishery during fishing year 1978-1979, and first quarter of fishing year 1979-1980.

Effective date	Action	Comments
October 1, 1978	Fishing year 1978-1979 enacted: October 1, 1978-September 30, 1979. Fishing year OY: 26000 MT (22000 MT, US commercial; 4000 MT, Canadian commercial). Quarterly quotas established for US mobile and fixed gear vessel classes. Trip limitations (pounds/week/vessel) established for all vessel classes: 0-60 GRT:4900; 61-125 GRT:9800; Over 125 GRT: 14000; fixed gear: 13000. Gear restrictions: minimum codend trawl mesh size of 5 1/8 inches; minimum gill net mesh size of 5 1/4 inches.	
November 19, 1978	Trip limitations revised: 0-60 GRT: 2500; 61-125 GRT: 9800; Over 125 GRT: 7000; fixed gear: 13000.	Catch rates during first month of quarter high and quarterly allocation likely to be exceeded before end of quarter. Thus, adjustments necessary.
November 11, 1978	Trip limitations revised: 0-60 GRT: 4900; 61-125 GRT: 4900; Over 125 GRT: 7000; fixed gear: 13000.	Previous announcement (Nov. 19) of trip limitations was in error.
December 17, 1978	Closure of commercial cod fishery for 125 GRT and over vessel class until beginning of next quarter (Jan. 1, 1979).	Fishery for 125 GRT and over vessel class must be closed to prevent quarterly quota from being exceeded.
January 1, 1979	Second quarter of fishing year begins. Trip limitations revised: 0-60 GRT: 4900; 61-125 GRT: 9800; Over 125 GRT: 14,000; fixed gear: 13000.	New quarter begins.
February 4, 1979	Adjustment of quarterly quota (all vessel classes): 0-60 GRT: 366 MT; 61-125 GRT: 1633 MT; Over 125 GRT: 2044 MT; fixed gear: 366 MT; total quarterly quota: 4609 MT.	Adjustments necessary to account for some vessel classes exceeding quotas during the first quarter.
July 22, 1979	OY revised: 34960 MT for fishing year Oct. 1, 1978-September 30, 1979 (30,960 MT, US commercial; 4000 MT, Canadian commercial). Trip limitations (pounds/week/vessel) revised: 0-60 GRT: 7000; 61-125 GRT: 14000; Over 125 GRT: 20000; fixed gear: 16000; Quarterly allocation for rest of fishing year revised to reflect revision of OY.	Actions reflect implementation of amendments to the FMP prepared by NERFMC.
October 1, 1979	First quarter of fishing year October 1, 1979-September 30, 1980 begins. First quarter quotas established for all vessel classes: 0-60 GRT: 501 MT; 61-125 GRT: 1777 MT; Over 125 GRT: 2958 MT; fixed gear: 404 MT; Trip limitations implemented on 22 July 1979 remain in effect. OY for new fishing year established identical to that during 1978-79 fishing year: 26000 MT (22000 MT, US commercial; 4000 MT, Canadian commercial). US commercial quarterly quotas for new fishing year established based on commercial allocation of 22000 MT.	New fishing year begins.
October 1, 1979- December 31, 1979	First quarter fishery regulated under OY and quarterly quotas as provided in Draft Amendment #4 to the FMP, under the supposition that these proposed actions would be approved by the Secretary of Commerce. The amendment proposed an OY for the 1979-80 fishing year of 35,000 MT (29620 MT, US commercial; 5380 MT, Canadian commercial), and first quarter US commercial vessel class quotas of: 0-60 GRT: 675 MT; 61-125 GRT: 2393 MT; Over 125 GRT: 3983; fixed gear: 544 MT; total first quarter US commercial quotas: 7595 MT.	Catches regulated under provisions of Draft Amendment #4 to the FMP.

Table 3. Quarterly commercial vessel class allocations (metric tons) of Atlantic cod for fishing year October 1, 1978 - September 30, 1979, and for calendar year 1979 for the Georges Bank and South, and Gulf of Maine Atlantic cod fisheries.

	Time Interval						
	Oct- Dec. 78	Jan- Mar. 79	Apr- <sup>1</sup> June 79	Jul- <sup>1</sup> Sept. 79	Annual <sup>1</sup> Fishing Year 1978-79	Oct- <sup>2</sup> Dec. 79	Calendar <sup>1,2</sup> Year 1979
<u>Georges Bank and South</u>							
Mobile Gear							
1-60 GRT	501	593	1012	582	2688	675	2862
61-125 GRT	1777	1567	3593	2168	9105	2393	9721
Over 125 GRT	2958	2129	4791	3764	13642	3983	14667
Fixed Gear	404	311	2364	2446	5525	544	5665
Total	5640	4600	11760	8960	30960	7595	32915
<u>Gulf of Maine</u>							
Mobile Gear							
1-60 GRT	581	699	1277	970	3527	921	3867
61-125 GRT	342	277	528	539	1686	542	1886
Over 125 GRT	180	171	110	112	573	285	678
Fixed Gear	317	253	1265	1259	3094	502	3279
Total	1420	1400	3180	2880	8880	2250	9710

<sup>1</sup> Reflects revisions to the FMP implemented on 22 July 1979.

<sup>2</sup> Reflects revisions proposed to the FMP in Draft Amendment No. 4 to the FMP.

Table 4. Percentage of USA commercial Atlantic cod from Georges Bank and south, and the Gulf of Maine, by market category, 1964-1979.

Year	Georges Bank and South				Gulf of Maine			
	Large	Market	Scrod	Total	Large	Market	Scrod	Total
1964	45	47	8	100	29	59	12	100
1965	56	40	3	99	39	54	7	100
1966	53	37	10	100	42	48	10	100
1967	41	42	16	99	41	41	17	99
1968	34	46	19	99	47	43	9	99
1969	27	57	16	100	35	55	9	99
1970	30	62	8	100	43	52	6	101
1971	40	51	9	100	52	42	6	100
1972	37	53	10	100	58	35	7	100
1973	24	40	36	100	52	36	11	99
1974	24	59	17	100	39	33	28	100
1975	28	62	10	100	32	42	26	100
1976	34	48	18	100	29	45	20	94 (6%mixed)
1977	26	39	34	99	33	42	22	97 (3%mixed)
1978	29	60	11	100	38	44	17	99
1979 <sup>1</sup>	37	55	8	100	38	49	11	99

<sup>1</sup>Provisional

Table 5. Stratified mean catch per tow in numbers and weight (lbs) for Atlantic cod from USA (NEFC) spring and autumn bottom trawl surveys on Georges Bank (Strata 13-25) and in the Gulf of Maine (Strata 26-30 and 36-40), 1963-1979.

Year	Georges Bank				Gulf of Maine			
	Spring <sup>1</sup>		Autumn		Spring <sup>1</sup>		Autumn	
	Nos	Wt (lbs)	Nos	Wt(lbs)	Nos	Wt(lbs)	Nos	Wt(lbs)
1963	-	-	2.80	24.2	-	-	3.79	24.4
1964	-	-	1.91	15.7	-	-	2.57	31.0
1965	-	-	2.72	15.9	-	-	2.88	16.3
1966	-	-	3.09	11.1	-	-	2.43	17.6
1967	-	-	6.66	18.4	-	-	1.64	12.5
1968	3.03	17.1	2.12	11.7	3.48	24.4	2.80	26.5
1969	2.97	24.2	1.41	10.9	2.08	18.0	1.77	20.9
1970	2.78	21.3	3.25	17.1	1.41	15.1	3.14	22.4
1971	2.17	19.3	2.04	13.4	0.92	9.5	2.80	22.5
1972	5.74	25.9	8.39	31.3	1.32	10.9	5.96	17.7
1973	36.91	128.0	7.87	42.0	4.82	25.6	2.85	11.9
1974	9.45	49.5	2.24	11.2	1.86	10.1	2.77	12.2
1975	4.42	35.5	4.11	19.1	1.61	8.2	3.94	11.7
1976	4.52	25.4	6.68	24.0	1.78	10.3	1.38	9.2
1977	4.04	21.0	4.42	25.4	2.48	11.6	2.49	20.7
1978	7.89	42.5	6.97	47.3	1.31	10.5	4.66	26.2
1979	3.30	23.0	4.82	33.5	2.74	12.9	2.23	23.8

<sup>1</sup>Spring surveys, 1968-1972, were accomplished with "36 Yankee" trawl; spring surveys from 1973 to 1979 were accomplished with "41 Yankee" trawl. No adjustments have been made to the catch per tow data for these gear differences.

Table 6. Stratified mean catch per tow (numbers) of Atlantic cod caught in autumn bottom trawl surveys on Georges Bank (Strata 13-25) and estimates of precision.

Year	Number of Tows	Stratified Mean Catch Per Tow (numbers, linear)						Stratified Mean Catch Per Tow (numbers, In [x + 1])						
		Mean	Variance	S.D.	2 S.D.	S.D. Mean	Mean $\pm$ 2 S.D.	Mean	Variance	S.D.	2 S.D.	S.D. Mean	Mean $\pm$ 2 S.D.	Factor Diff.
1963	57	2.80	0.63	0.79	1.59	0.28	1.21-4.39	0.76	.02021	0.14	0.28	0.19	0.48-1.04	1.8
1964	63	1.80	0.16	0.40	0.79	0.22	1.01-2.59	0.58	.01051	0.10	0.21	0.18	0.37-0.79	1.5
1965	66	2.72	0.64	0.80	1.60	0.29	1.12-4.32	0.70	.01431	0.12	0.14	0.17	0.46-0.94	1.3
1966	67	3.09	0.57	0.76	1.51	0.24	1.58-4.60	0.74	.01048	0.10	0.20	0.14	0.54-0.94	1.5
1967	67	6.62	2.90	1.70	3.40	0.26	3.22-10.02	1.18	.02189	0.15	0.30	0.13	0.88-1.48	1.8
1968	69	2.12	0.26	0.51	1.02	0.24	1.10-3.14	0.56	.00878	0.09	0.19	0.17	0.37-0.75	1.5
1969	73	1.41	0.07	0.26	0.52	0.18	0.89-1.93	0.58	.00641	0.08	0.16	0.14	0.42-0.74	1.4
1970	70	3.25	0.31	0.56	1.12	0.17	2.13-4.37	0.77	.01045	0.10	0.20	0.13	0.57-0.97	1.5
1971	73	2.04	0.19	0.44	0.88	0.22	1.16-2.92	0.63	.01017	0.10	0.20	0.16	0.43-0.83	1.5
1972	73	8.39	3.96	1.99	3.98	0.24	4.41-12.37	1.05	.01070	0.10	0.21	0.10	0.84-1.26	1.5
1973	73	7.87	3.49	1.87	3.74	0.24	4.13-11.61	1.08	.02089	0.14	0.29	0.13	0.79-1.37	2.0
1974	74	2.24	0.23	0.48	0.95	0.21	1.29-3.19	0.53	.00844	0.09	0.18	0.17	0.35-0.71	1.4
1975	73	4.11	4.28	2.07	4.14	0.50	-0.03-8.25	0.65	.01078	0.10	0.21	0.16	0.44-0.86	1.5
1976	67	6.68	4.34	2.08	4.17	0.31	2.51-10.85	0.92	.02377	0.15	0.31	0.17	0.61-1.23	1.9
1977	101	4.42	0.51	0.72	1.44	0.16	2.98-5.86	0.92	.00659	0.08	0.16	0.09	0.76-1.08	1.4
1978	156	6.97	1.15	1.07	2.15	0.15	4.82-9.12	1.02	.00771	0.09	0.18	0.09	0.84-1.20	1.4
1979 <sup>1</sup>	145	4.82	0.87	0.93	1.87	0.19	2.95-6.69	0.95	.00779	0.09	0.18	0.09	0.77-1.13	1.4

<sup>1</sup>Provisional

Table 7. Stratified mean catch per tow (weight:lbs) of Atlantic cod caught in autumn bottom trawl surveys on Georges Bank (Strata 13-25) and estimates of precision.

Year	Stratified Mean Catch Per Tow (lbs linear)							Stratified Mean Catch Per Tow (lbs., ln [x + 1])						
	Number of Tows	Mean	Variance	S.D.	2 S.D.	S.D. Mean	Mean <sup>±</sup> 2 S.D.	Mean	Variance	S.D.	2 S.D.	S.D. Mean	Mean <sup>±</sup> 2 S.D.	Factor Diff.
1963	57	24.18	43.34	6.58	13.17	0.27	11.01-37.35	1.75	.08481	0.29	0.58	0.17	1.17-2.33	3.2
1964	63	15.75	20.89	4.57	9.14	0.29	6.61-24.89	1.29	.05624	0.24	0.47	0.18	0.82-1.76	2.6
1965	66	15.90	26.04	5.10	10.21	0.32	5.69-26.11	1.33	.04176	0.20	0.41	0.15	0.92-1.74	2.3
1966	67	11.10	5.87	2.42	4.85	0.22	6.25-15.95	1.20	.04065	0.20	0.40	0.17	0.80-1.60	2.2
1967	67	18.43	17.85	4.22	8.45	0.23	9.95-26.95	1.74	.04735	0.22	0.44	0.13	1.30-2.18	2.4
1968	69	11.66	8.54	2.92	5.84	0.25	5.86-17.54	1.04	.03192	0.18	0.36	0.17	0.68-1.40	2.1
1969	73	10.91	4.79	2.19	4.38	0.20	6.52-15.28	1.32	.02541	0.16	0.32	0.12	1.00-1.64	1.9
1970	70	17.07	10.27	3.21	6.41	0.19	10.69-23.51	1.40	.03427	0.19	0.37	0.13	1.03-1.77	2.1
1971	73	13.88	11.68	3.42	6.83	0.26	6.57-20.23	1.23	.03030	0.17	0.35	0.14	0.88-1.58	2.0
1972	73	31.27	129.63	11.39	22.77	0.36	8.53-54.07	1.74	.01659	0.13	0.26	0.07	1.48-2.00	1.7
1973	73	41.97	150.76	12.28	24.56	0.29	17.44-66.56	1.78	.05006	0.22	0.45	0.13	1.33-2.23	2.5
1974	74	11.19	5.68	2.38	4.77	0.21	6.43-15.97	1.01	.03677	0.19	0.38	0.19	0.63-1.39	2.1
1975	73	19.13	61.80	7.86	15.72	0.41	3.38-34.82	1.34	.02655	0.16	0.33	0.12	1.01-1.67	1.9
1976	67	24.04	33.10	5.75	10.51	0.24	12.53-35.55	1.62	.03077	0.18	0.35	0.11	1.27-1.97	2.0
1977	101	25.44	12.85	3.58	7.17	0.14	18.27-32.61	1.81	.01836	0.14	0.27	0.07	1.54-2.08	1.7
1978	156	47.30	52.45	7.24	14.48	0.15	32.82-61.78	1.96	.01839	0.14	0.27	0.07	1.69-2.23	1.7
1979 <sup>1</sup>	145	33.52	18.74	4.33	8.66	0.13	24.86-42.18	1.93	.02374	0.15	0.31	0.08	1.62-2.24	1.9

<sup>1</sup>Provisional

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Table 8. Number of tows, total number of Atlantic cod caught, and total weight (lbs) of Atlantic cod caught in USA spring and autumn bottom trawl surveys on Georges Bank (Strata 13-25) and in the Gulf of Maine (Strata 26-30 and 36-40), 1963-1979.

Year	Georges Bank						Gulf of Maine					
	Spring			Autumn			Spring			Autumn		
	Number of tows	Total No. of cod caught	Total weight (lbs) of cod caught	Number of tows	Total No. of cod caught	Total weight (lbs) of cod caught	Number of tows	Total No. of cod caught	Total weight (lbs) of cod caught	Number of tows	Total No. of cod caught	Total weight (lbs) of cod caught
1963	-	-	-	57	178	1,262	-	-	-	57	296	1,815
1964	-	-	-	63	146	1,083	-	-	-	47	121	1,324
1965	-	-	-	66	201	954	-	-	-	48	241	1,341
1966	-	-	-	67	263	891	-	-	-	45	180	1,163
1967	-	-	-	67	430	1,379	-	-	-	48	97	711
1968	69	204	1,504	69	205	1,095	49	210	1,401	50	144	1,307
1969	74	203	1,684	73	105	754	53	137	1,193	51	124	1,315
1970	69	164	1,236	70	258	1,247	52	115	1,256	53	216	1,150
1971	73	169	1,288	73	161	926	57	66	681	55	228	1,668
1972	76	413	1,896	73	827	3,104	55	86	740	55	469	1,051
1973	71	2,650	9,141	73	664	3,174	48	369	1,947	54	229	789
1974	66	600	3,118	74	234	1,005	47	140	667	57	220	756
1975	71	305	2,380	73	345	1,408	52	206	808	65	687	1,523
1976	69	319	1,788	67	402	1,126	64	236	1,050	55	127	671
1977	71	306	1,674	101	694	3,337	67	342	1,396	71	264	1,869
1978	79	613	3,578	156	1,194	7,836	66	112	861	120	781	3,558
1979	127	526	3,266	145	806	5,370	72	267	1,406	129	420	3,563

Table 9. Stratified mean catch per tow at age (numbers) of Atlantic cod from USA autumn bottom trawl surveys on Georges Bank (Strata 13-25) and in the Gulf of Maine (Strata 26-30 and 36-40), 1970-1979.

Year	Age													Totals					
	0	1	2	3	4	5	6	7	8	9	10	11	12+	0+	1+	2+	3+	4+	5+
<u>Georges Bank</u>																			
1970	.265	1.082	.867	.336	.445	.098	.000	.021	.035	.035	.063	.000	.000	3.247	2.982	1.900	1.033	.697	.252
1971	.256	.386	.405	.250	.193	.305	.117	.027	.057	.000	.000	.000	.048	2.044	1.788	1.402	.997	.747	.554
1972	.607	4.771	.830	1.135	.256	.156	.366	.070	.131	.014	.006	.000	.047	8.389	7.782	3.011	2.181	1.046	.790
1973	.130	1.121	3.891	.758	1.290	.135	.145	.112	.040	.089	.085	.023	.053	7.872	7.742	6.621	2.730	1.972	.682
1974	.296	.262	.419	.975	1.105	.073	.066	.000	.044	.000	.000	.000	.000	2.240	1.944	1.682	1.263	.288	.183
1975	1.524	.637	.270	.400	1.080	.072	.100	.000	.000	.000	.024	.000	.000	4.107	2.583	1.946	1.676	1.276	.196
1976	.000	3.941	1.328	.489	.178	.474	.035	.173	.024	.034	.000	.013	.000	6.690	6.690	2.749	1.421	.932	.754
1977	.123	.192	2.778	.570	.204	.141	.321	.006	.022	.000	.007	.042	.014	4.420	4.297	4.105	1.327	.757	.553
1978 <sup>1</sup>	.321	1.505	.207	3.392	.782	.272	.134	.279	.041	.024	.000	.000	.011	6.968	6.647	5.142	4.935	1.543	.761
1979 <sup>1</sup>	(.096) (1.210)													4.848					
<u>Gulf of Maine</u>																			
1970	.476	.603	.170	.353	.211	.313	.271	.506	.084	.060	.023	.024	.047	3.141	2.665	2.062	1.892	1.539	1.328
1971	.863	.114	.153	.135	.383	.295	.278	.163	.204	.128	.040	.022	.020	2.798	1.935	1.821	1.668	1.533	1.150
1972	.020	3.576	.780	.978	.150	.060	.110	.025	.102	.155	.000	.000	.010	5.966	5.946	2.370	1.590	.612	.462
1973	.408	.210	1.393	.089	.325	.136	.050	.018	.033	.108	.077	.000	.010	2.857	2.449	2.239	.846	.757	.432
1974	.181	.720	.121	1.118	.187	.230	.050	.008	.008	.027	.021	.075	.031	2.777	2.596	1.876	1.755	.637	.450
1975	.030	.094	1.966	.086	1.510	.163	.070	.011	.002	.002	.000	.004	.004	3.942	3.912	3.818	1.852	1.766	.256
1976	.000	.156	.134	.405	.064	.492	.037	.061	.000	.010	.020	.000	.000	1.379	1.379	1.223	1.089	.684	.620
1977	.000	.018	.291	.446	.937	.123	.481	.031	.079	.018	.027	.000	.051	2.502	2.502	2.484	2.193	1.747	.810
1978	.202	1.111	.301	.907	.532	1.160	.091	.264	.007	.049	.000	.010	.031	4.665	4.463	3.352	3.051	2.144	1.612
1979 <sup>1</sup>	(.000) (.097)													2.280					

<sup>1</sup>Survey age samples currently being analyzed.

Table 10. Stratified mean catch per tow at age (numbers) of Atlantic cod from USA spring bottom trawl surveys on Georges Bank (Strata 13-25) and in the Gulf of Maine (Strata 26-30 and 36-40), 1970-1979.<sup>1</sup>

Year	Age													Totals					
	0	1	2	3	4	5	6	7	8	9	10	11	12+	0+	1+	2+	3+	4+	5+
<u>Georges Bank</u>																			
1970	.000	.244	.522	.308	.830	.104	.420	.176	.039	.087	.008	.000	.045	2.783	2.783	2.539	2.017	1.709	.879
1971	.000	.133	.525	.322	.143	.375	.091	.225	.195	.051	.032	.032	.048	2.172	2.172	2.039	1.514	1.192	1.049
1972	.036	1.860	1.175	1.693	.327	.076	.208	.078	.141	.074	.032	.009	.039	5.748	5.712	3.852	2.677	.984	.657
1973	.036	.334	27.000	4.035	4.117	.418	.325	.244	.032	.126	.110	.025	.111	36.913	36.877	36.543	9.543	5.508	1.391
1974	.000	.286	2.921	3.828	.488	1.284	.282	.065	.165	.022	.059	.016	.037	9.453	9.453	9.167	6.246	2.418	1.930
1975	.000	.041	.242	1.309	1.982	.167	.440	.083	.060	.069	.000	.000	.025	4.418	4.418	4.377	4.135	2.826	.844
1976	.071	.834	1.232	.605	.443	1.008	.105	.168	.023	.000	.000	.000	.035	4.524	4.453	3.619	2.387	1.782	1.339
1977	.000	.018	2.261	.692	.335	.179	.466	.033	.042	.000	.000	.000	.013	4.039	4.039	4.021	1.760	1.068	.733
1978	2.123	.241	.120	3.545	.621	.499	.092	.457	.033	.091	.039	.000	.031	7.892	5.769	5.528	5.408	1.863	1.242
1979	.070	.278	.872	.187	1.229	.347	.150	.056	.093	.008	.000	.000	.014	3.304	3.234	2.956	2.084	1.897	.668
<u>Gulf of Maine</u>																			
1970	.000	.102	.079	.035	.060	.175	.299	.394	.048	.038	.063	.064	.057	1.414	1.414	1.312	1.233	1.198	1.138
1971	.000	.016	.091	.070	.187	.031	.053	.192	.132	.099	.038	.008	.000	.917	.917	.901	.810	.740	.553
1972	.000	.226	.098	.333	.126	.128	.023	.068	.065	.147	.036	.036	.033	1.319	1.319	1.093	.995	.662	.536
1973	.000	.022	2.724	.581	.397	.224	.125	.061	.143	.161	.134	.048	.210	4.830	4.830	4.808	2.084	1.503	1.106
1974	.000	.305	.036	.871	.211	.142	.073	.031	.031	.013	.037	.028	.084	1.862	1.862	1.557	1.521	.650	.439
1975	.004	.060	.448	.068	.683	.166	.071	.003	.003	.012	.036	.017	.039	1.610	1.606	1.546	1.098	1.030	.347
1976	.000	.027	.195	.672	.098	.575	.055	.069	.042	.000	.007	.003	.037	1.780	1.780	1.753	1.558	.886	.788
1977	.000	.016	.191	.334	1.278	.070	.507	.004	.065	.000	.000	.000	.024	2.489	2.489	2.473	2.282	1.948	.670
1978	.000	.022	.067	.183	.223	.491	.048	.205	.005	.068	.000	.005	.000	1.317	1.317	1.295	1.228	1.045	.822
1979	.028	.343	1.045	.136	.322	.256	.439	.038	.091	.008	.012	.000	.022	2.740	2.712	2.369	1.324	1.188	.866

<sup>1</sup>Spring surveys, 1968-1972, were accomplished with "36 Yankee" trawl; spring surveys from 1973-1978 were accomplished with "41 Yankee" trawl. No adjustments have been made to the catch per tow at age data for these gear differences.

Table 11. Relationship between total commercial landings of Atlantic cod (3-year averages),<sup>1</sup> total commercial and recreational landings of Atlantic cod (3-year averages)<sup>1</sup>, and USA autumn bottom trawl survey stratified mean catch (weight in pounds) per tow (3-year averages)<sup>1</sup> from Georges Bank (strata 13-25) and the Gulf of Maine (strata 26-30 and 36-40), 1963-1979. Landings data are in thousands of metric tons, live weight.

	Georges Bank					Gulf of Maine				
	Commercial landings (A)	Commercial & recreational landings (B)	Autumn survey wt/tow (C)	Relative Exploitation Rates		Commercial landings (D)	Commercial & recreational landings (E)	Autumn survey wt/tow (F)	Relative Exploitation Rates	
				A/C	B/C				D/F	E/F
1964	30.2	42.4	18.6	1.62	2.28	3.3	5.4	23.9	0.14	0.23
1965	38.9	50.4	14.2	2.74	3.55	3.9	6.3	21.6	0.18	0.29
1966	42.7	54.3	15.1	2.83	3.60	4.8	7.7	15.5	0.31	0.50
1967	44.3	56.8	13.7	3.23	4.15	5.6	8.5	18.9	0.30	0.45
1968	39.3	52.9	13.7	2.87	3.86	7.0	10.0	20.0	0.35	0.50
1969	35.6	49.5	13.2	2.70	3.75	7.7	10.6	23.3	0.33	0.45
1970	30.6	44.8	13.8	2.22	3.26	8.1	11.1	21.9	0.37	0.51
1971	26.3	39.5	20.6	1.28	1.92	7.6	10.4	20.9	0.36	0.50
1972	27.4	39.1	28.9	0.95	1.35	6.9	9.3	17.4	0.40	0.53
1973	27.1	37.4	28.2	0.96	1.33	6.9	9.2	13.9	0.50	0.66
1974	27.1	36.3	24.1	1.12	1.51	7.6	9.9	11.9	0.64	0.83
1975	24.1	33.0	18.1	1.33	1.82	9.0	11.6	11.0	0.82	1.05
1976	24.1		22.8	1.06		10.6		13.9	0.76	0.90
1977	27.6		32.2	0.86		11.8		18.7	0.63	
1978	33.3		35.4	0.94		12.4		23.6	0.53	
1979 <sup>2</sup>	36.3		40.4	0.90		12.3		25.0	0.49	

<sup>1</sup> Average values calculated as  $\frac{E \text{ year } i-1 + \text{year } i + \text{year } i+1}{3}$ .

<sup>2</sup> 1979 Average values calculated as  $\frac{E \text{ year } 1978 + \text{year } 1979}{2}$ .

Table 12. Atlantic cod landings (metric tons, live) from the Gulf of Maine (ICNAF Div. 5Y), by country, 1960-1979.

	Country					Total commercial	USA recreational	Grand Total
	USA	Canada	USSR	Spain	Other			
1960	3,448	129	-	-	-	3,577	2,621	6,198 <sup>1</sup>
1961	3,216	18	-	-	-	3,234	2,444	5,678
1962	2,989	83	-	-	-	3,072	2,272	5,344
1963	2,595	3	133	-	-	2,731	1,713	4,444
1964	3,226	25	-	-	-	3,251	2,129	5,380
1965	3,780	148	-	-	-	3,928	2,537	6,465 <sup>1</sup>
1966	4,008	384	-	-	-	4,392	2,645	7,037
1967	5,676	297	-	-	-	5,973	3,746	9,719
1968	6,360	61	-	-	-	6,421	2,417	8,838
1969	8,157	59	-	152	116	8,484	3,100	11,584
1970	7,812	26	-	375	48	8,261	3,046	11,307 <sup>1</sup>
1971	7,380	119	-	159	4	7,662	2,804	10,466
1972	6,776	53	11	-	77	6,917	2,575	9,492
1973	6,069	68	-	-	9	6,146	1,821	7,967 <sup>1</sup>
1974	7,639	120	-	4	1	7,764	2,313	10,077 <sup>1</sup>
1975	8,903	86	-	26	-	9,015	2,671	11,686
1976	10,172	16	-	-	-	10,188	2,963	13,151
1977 <sup>2</sup>	12,426 <sup>3</sup>	106	-	-	-	12,532	-	12,532 <sup>4</sup>
1978 <sup>2</sup>	12,426 <sup>3</sup>	384	-	-	-	12,810	-	12,810
1979 <sup>2</sup>	11,424 <sup>3</sup>	315	-	-	-	11,739	-	11,739 <sup>4</sup>

<sup>1</sup>From angler surveys; remaining years estimated.

<sup>2</sup>Provisional.

<sup>3</sup>Reported USA landings may underestimate actual commercial catch due to unreported catch.

<sup>4</sup>Does not include recreational landings.

<sup>5</sup>Estimated.

Source: ICNAF Statistical Bulletins 1960-1977.

ICNAF Summary Document 79/VI/30 (Revised January 1980).

NMFS Fisheries Management and Statistics Branch (1979 USA landings)

Table 13. Fishery management actions in the Gulf of Maine Atlantic cod fishery during fishing year 1978-1979, and first quarter of fishing year 1979-1980.

Effective Date	Action	Comments
October 1, 1978	Fishing year 1978-1979 enacted: October 1, 1978-September 30, 1979. Fishing year OY: 8500 MT (6000 MT, US commercial; 2500 MT US recreational for charter and head boats). Quarterly quotas established for US commercial mobile and fixed gear vessel classes. Trip limitations (pounds/week/vessel) established for all vessel classes: 0-60 GRT: 2500; 61-125 GRT: 5000; Over 125 GRT: 7000; fixed gear: 5000. Gear restrictions: minimum codend trawl mesh size of 5 1/8 inches; minimum gill net mesh size of 5 1/2 inches.	
November 12, 1978	Closure of commercial cod fishery for 125 GRT and over vessel class until beginning of next quarter (Jan. 1, 1979); Trip limitations revised: 0-60 GRT: 2500; 61-125 GRT: 2500; Over 125 GRT: closed; fixed gear: 5000.	Catch rates during first month of quarter high and some quarterly allocations are likely to be exceeded before end of quarter. Thus, closure and trip adjustments necessary.
November 19, 1978	Commercial cod fishery for 125 GRT and over vessel class closed until beginning of next quarter (Jan. 1, 1979). Trip limitations of 12 November continue and are restated.	Previous announcement (Nov. 12) did not provide fishermen adequate notice of closure and trip limit revisions.
December 17, 1978	Closure of commercial cod fishery for fixed gear vessel class until beginning of next quarter (Jan. 1, 1979); Trip limitations revised to conform to closure action: 0-60 GRT: 2500; 61-125 GRT: 2500; Over 125 GRT: closed Nov. 19; fixed gear: closed Dec. 17.	Fishery for fixed gear vessel class must be closed to prevent quarterly quota from being exceeded.
January 1, 1979	Second quarter of fishing year begins. Closure of commercial cod fishery for 125 GRT and over vessel class until beginning of next quarter (April 1, 1979). Trip limitations revised: 0-60 GRT: 2500; 61-125 GRT: 5000; Over 125 GRT: closed Jan. 1; fixed gear: 5000.	New quarter begins. Over 125 GRT vessel class fishery remains closed since first quarter landings exceeded allocations for the first two quarters.
February 4, 1979	Closure of commercial cod fishery for 61-125 GRT vessel class until beginning of next quarter (April 1, 1979); adjustment of quarterly quota (all vessel classes): 0-60 GRT: 515 MT; 61-125 GRT: 130 MT; Over 125 GRT: 0 MT; fixed gear: 104 MT; total quarterly quota: 749 MT. Trip limitations revised: 0-60 GRT: 2500; 61-125 GRT: closed Feb. 4; Over 125 GRT: closed Jan. 1; fixed gear: 2500.	Adjustments necessary to account for some vessel classes exceeding quotas during first quarter. Closure for 61-125 GRT vessel class necessary to prevent quarterly quota from being exceeded.
March 13, 1979	Reopening of fishery for 61-125 GRT vessel class; Revision of trip limitations: 0-60 GRT: 2500; 61-125 GRT: 2500; Over 125 GRT: closed Jan. 1; fixed gear: 5000.	NERFMC asked Secretary of Commerce to rescind closure explaining that quarterly allocations were intended to serve as guideposts and that there was no intention that quarterly overruns automatically required fishery closures.
April 22, 1979	Closure of commercial cod fishery for 61-125 GRT vessel class until beginning of next fishing year (1 Oct. 1979). Revision of trip limitations to reflect this action: 0-60 GRT: 2500; 61-125: closed Apr. 22; Over 125 GRT: closed Jan. 1; fixed gear: 5000.	Closure for 61-125 GRT vessel class necessary since entire annual fishing year quota for this class has been reached already.
July 22, 1979	OY revised: 11380 for fishing year Oct. 1, 1978-Sept. 30, 1979 (8880 MT, US commercial; 2500 US recreational for charter and lead boats). Closure of commercial cod fishery for 0-60 GRT vessel class and fixed gear vessel class until beginning of next fishing year (1 Oct. 1979). Thus, all commercial cod fisheries in the Gulf of Maine are closed until Oct. 1, 1979 since fishery closures for the remaining vessel classes were implemented earlier in the fishing year.	OY revision reflects implementation of amendments to the FMP prepared by NERFMC. Closure of fishery is necessary to prevent remaining vessel class annual allocations from being exceeded.
October 1, 1979	First quarter of fishing year Oct. 1, 1979-Sept. 30, 1980 begins. First quarter quotas established for all vessel classes: 0-60 GRT: 581 MT; 61-125 GRT: 542 MT; Over 125 GRT: 180 MT; fixed gear: 317 MT; trip limitations reestablished (pounds/week/vessel): 0-60 GRT: 2500; 61-125 GRT: 5000; Over 125 GRT: 7000; fixed gear: 5000. OY for new fishing year established identical to that during 1978-1979 fishing year: 8500 MT (6000 MT, US commercial; 2500 MT, US recreational for charter and head boats). Quarterly US commercial quotas for new fishing year established based on annual allocation of 6000 MT.	New fishing year begins.
October 1, 1979- December 31, 1979	First quarter fishery regulated under OY and quarterly quotas as provided in Draft Amendment #4 to the FMP, under the supposition that these proposed actions would be approved by the Secretary of Commerce. The amendment proposed an OY for the 1979-80 fishing year of 12000 MT (9500 MT, US commercial; 2500 MT, US recreational for charter and head boats, and first quarter US commercial vessel class quotas of: 0-60 GRT: 921 MT; 61-125 GRT: 542 MT; Over 125 GRT: 285 MT; fixed gear: 502 MT; total first quarter US commercial quota: 2250 MT.	Catches regulated under provisions of Draft Amendment #4 to the FMP.

Table 14. Stratified mean catch per tow (numbers) of Atlantic cod caught in autumn bottom trawl surveys in the Gulf of Maine (Strata 26-30; 36-40) and estimates of precision.

Year	Number of Tows	Stratified Mean Catch Per Tow (numbers, linear)						Stratified Mean Catch Per Tow (numbers, ln [x + 1])						Factor Diff.
		Mean	Variance	S.D.	2 S.D.	S.D. Mean	Mean $\pm$ 2 S.D.	Mean	Variance	S.D.	2 S.D.	S.D. Mean	Mean $\pm$ 2 S.D.	
1963	57	3.79	1.48	1.21	2.43	0.32	1.36-6.22	0.71	.015252	.1235	.25	.17	.46-.96	1.6
1964	47	2.57	1.33	1.15	2.30	0.45	0.27-4.87	0.53	.021928	.1481	.30	.28	.23-.83	1.8
1965	48	2.88	0.84	0.92	1.83	0.32	1.05-4.71	0.55	.007762	.0881	.18	.16	.37-.73	1.4
1966	45	2.43	0.32	0.57	1.14	0.23	1.29-3.57	0.61	.013280	.1152	.23	.19	.38-.84	1.6
1967	48	1.64	0.18	0.42	0.85	0.26	0.79-2.49	0.60	.014087	.1187	.24	.20	.36-.84	1.6
1968	50	2.80	0.33	0.57	1.15	0.20	1.65-3.95	0.84	.013891	.1179	.24	.14	.60-1.08	1.6
1969	51	1.77	0.09	0.30	0.60	0.17	1.17-2.37	0.59	.007755	.0881	.18	.15	.41-.77	1.4
1970	53	3.14	1.19	1.09	2.18	0.35	0.96-5.32	0.69	.015244	.1235	.25	.18	.44-.94	1.6
1971	55	2.80	0.39	0.62	1.25	0.22	1.55-4.05	0.60	.007453	.0863	.17	.14	.43-.77	1.4
1972	55	5.96	11.90	3.45	6.90	0.58	-0.94-12.86	0.86	.011808	.1087	.22	.13	.64-1.06	1.6
1973	54	2.85	0.24	0.49	0.98	0.17	1.87-3.83	0.66	.007407	.0861	.17	.13	.49-.83	1.4
1974	57	2.77	0.61	0.78	1.56	0.28	1.21-4.33	0.65	.088601	.0927	.19	.14	.46-.84	1.5
1975	65	3.94	0.81	0.90	1.80	0.23	2.14-5.74	0.79	.007097	.0842	.17	.11	.62-.96	1.4
1976	55	1.38	0.09	0.30	0.60	0.22	0.78-1.98	0.51	.008053	.0897	.18	.18	.33-.69	1.4
1977	71	2.49	0.11	0.34	0.67	0.14	1.82-3.16	0.87	.007911	.0889	.18	.10	.69-1.05	1.4
1978	120	4.68	0.86	0.93	1.86	0.20	2.82-6.54	0.96	.011614	.1078	.22	.11	.74-1.18	1.6
1979 <sup>1</sup>	129	2.23	0.07	0.26	0.51	0.12	1.72-2.74	0.78	.004443	.0667	.13	.09	.65-.91	1.3

<sup>1</sup>Provisional

Table 15. Stratified mean catch per tow (weight:lbs) of Atlantic cod caught in autumn bottom trawl surveys in the Gulf of Maine (Strata 26-30; 36-40) and estimates of precision.

Year	Stratified Mean Catch Per Tow (lbs, linear)							Stratified Mean Catch Per Tow (lbs., ln [x +1])						
	Number of Tows	Mean	Variance	S.D.	2 S.D.	S.D. Mean	Mean $\pm$ 2 S.D.	Mean	Variance	S.D.	2 S.D.	S.D. Mean	Mean $\pm$ 2 S.D.	Factor Diff.
1963	57	24.43	101.60	10.08	20.16	0.41	4.27-44.59	1.35	.047642	0.2183	0.44	0.16	.91-1.79	2.4
1964	47	31.02	267.87	16.64	33.28	0.54	-2.26-64.30	1.13	.079855	0.2826	0.57	0.25	.56-1.70	3.1
1965	48	16.34	25.44	5.04	10.09	0.31	6.25-26.43	1.23	.045294	0.2128	0.43	0.17	.80-1.66	2.4
1966	45	17.58	20.53	4.53	9.06	0.26	8.52-26.64	1.31	.067367	0.2596	0.52	0.20	0.79-1.83	2.8
1967	48	12.55	9.51	3.08	6.17	0.25	6.38-18.72	1.36	.065246	0.2554	0.51	0.19	0.85-1.87	2.8
1968	50	26.45	33.02	5.75	11.49	0.22	14.96-37.94	1.87	.054006	0.2324	0.46	0.12	1.41-2.33	2.5
1969	51	20.92	26.50	5.15	10.30	0.25	10.62-31.22	1.46	.055871	0.2364	0.47	0.16	0.99-1.93	2.6
1970	53	22.37	35.26	5.94	11.88	0.27	10.49-34.25	1.68	.072580	0.2694	0.54	0.16	1.14-2.22	2.9
1971	55	22.49	56.76	7.53	15.07	0.33	7.42-37.56	1.27	.055047	0.2346	0.47	0.18	0.80-1.74	2.6
1972	55	17.67	16.55	4.07	8.14	0.23	9.53-25.81	1.78	.047733	0.2185	0.44	0.12	1.34-2.22	2.4
1973	54	11.93	12.94	3.60	7.19	0.30	4.74-19.12	1.34	.040234	0.2006	0.40	0.15	0.94-1.74	2.2
1974	57	12.19	7.26	2.69	5.39	0.22	6.80-17.58	1.39	.036695	0.1916	0.38	0.14	1.01-1.77	2.1
1975	65	11.73	3.60	1.90	3.79	0.16	7.94-15.52	1.40	.028602	0.1691	0.34	0.12	1.06-1.74	2.0
1976	55	9.17	5.03	2.24	4.48	0.24	4.69-13.65	1.18	.044813	0.2117	0.42	0.18	0.76-1.60	2.3
1977	71	20.72	7.48	2.73	5.47	0.13	15.25-26.19	2.06	.044507	0.2110	0.42	0.10	1.64-2.58	2.3
1978	120	26.20	18.19	4.26	8.53	0.16	17.67-34.73	1.85	.039148	0.1979	0.40	0.11	1.45-2.25	2.2
1979 <sup>1</sup>	129	23.85	11.15	3.34	6.68	0.14	17.17-30.53	1.93	.030672	0.1751	0.35	0.09	1.58-2.28	2.0

<sup>1</sup>Provisional

Table 16. Stratified mean catch per tow (numbers) of Atlantic cod caught in spring bottom trawl surveys in the Gulf of Maine (Strata 26-30; 36-40), 1968-1979.<sup>1</sup>

Year	Linear		Log <sub>e</sub> (x + 1)		Re-Transformed	
	Mean	Confidence Limits	Mean	Confidence Limits	Mean	Confidence Limits
1968	3.48	2.45-4.52	0.84	0.63-1.05	2.77	2.06-3.65
1969	2.08	0.61-3.55	0.49	0.27-0.71	1.42	0.94-2.01
1970	1.40	0.69-2.12	0.43	0.31-0.56	1.03	0.80-1.30
1971	0.92	0.54-1.29	0.44	0.31-0.57	0.84	0.61-1.10
1972	1.32	0.71-1.92	0.50	0.34-0.65	1.14	0.84-1.50
1973	4.82	1.25-8.40	0.72	0.53-0.91	2.54	1.92-3.29
1974	1.86	1.09-2.63	0.55	0.37-0.73	1.45	1.05-1.93
1975	1.61	0.82-2.40	0.51	0.32-0.70	1.23	0.84-1.70
1976	1.78	1.10-2.47	0.61	0.45-0.77	1.45	1.09-1.88
1977	2.48	1.16-3.81	0.62	0.42-0.82	1.82	1.31-2.44
1978	1.31	0.78-1.85	0.50	0.35-0.65	1.14	0.84-1.49
1979	2.74	1.32-4.15	0.78	0.58-0.98	2.27	1.68-2.99

<sup>1</sup> Spring surveys, 1968-1972, were accomplished with "36 Yankee" trawl; spring surveys from 1973-1979 were accomplished with "41 Yankee" trawl. No adjustments have been made to the catch per tow data for these gear differences.

Table 17. Stratified mean catch per tow (weight in pounds) of Atlantic cod caught in spring bottom trawl surveys in the Gulf of Maine (Strata 26-30; 36-40), 1968-1979.<sup>1</sup>

Year	Linear		Log <sub>e</sub> (x + 1)		Re-Transformed	
	Mean	Confidence Limits	Mean	Confidence Limits	Mean	Confidence Limits
1968	24.36	16.20-32.52	1.90	1.44-2.37	33.96	20.96-54.65
1969	17.96	5.17-30.75	1.06	0.65-1.46	11.33	7.23-17.48
1970	15.08	6.65-23.50	1.04	0.74-1.33	9.35	6.70-12.92
1971	9.52	5.02-14.02	1.16	0.78-1.54	8.56	5.53-12.97
1972	10.92	5.49-16.35	1.09	0.73-1.45	8.91	5.95-13.15
1973	25.58	2.91-48.25	1.51	1.14-1.88	17.68	11.88-26.10
1974	10.09	5.79-14.39	1.11	0.70-1.53	9.29	5.81-14.56
1975	8.21	3.61-12.81	1.01	0.61-1.41	6.26	3.85- 9.88
1976	10.28	6.69-13.88	1.37	0.97-1.77	10.96	7.02-16.81
1977	11.62	6.39-16.86	1.11	0.75-1.47	8.99	5.96-13.35
1978	10.47	5.75-15.20	1.07	0.73-1.41	8.27	5.60-12.03
1979	12.92	7.87-17.97	1.49	1.12-1.86	13.00	8.67-19.27

<sup>1</sup>Spring surveys, 1968-1972, were accomplished with "36 Yankee" trawl; spring surveys from 1973-1979 were accomplished with "41 Yankee" trawl. No adjustments have been made to the catch per tow data for these gear differences.

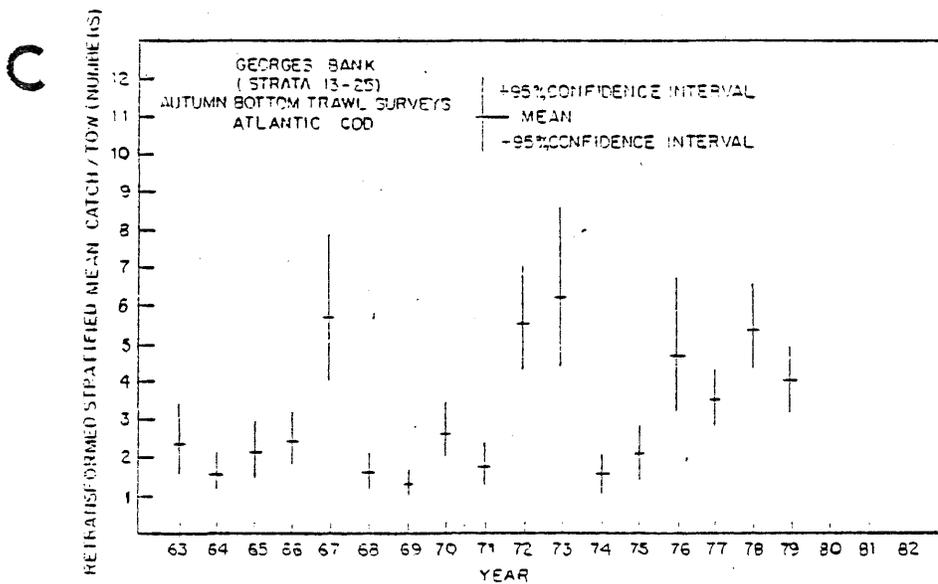
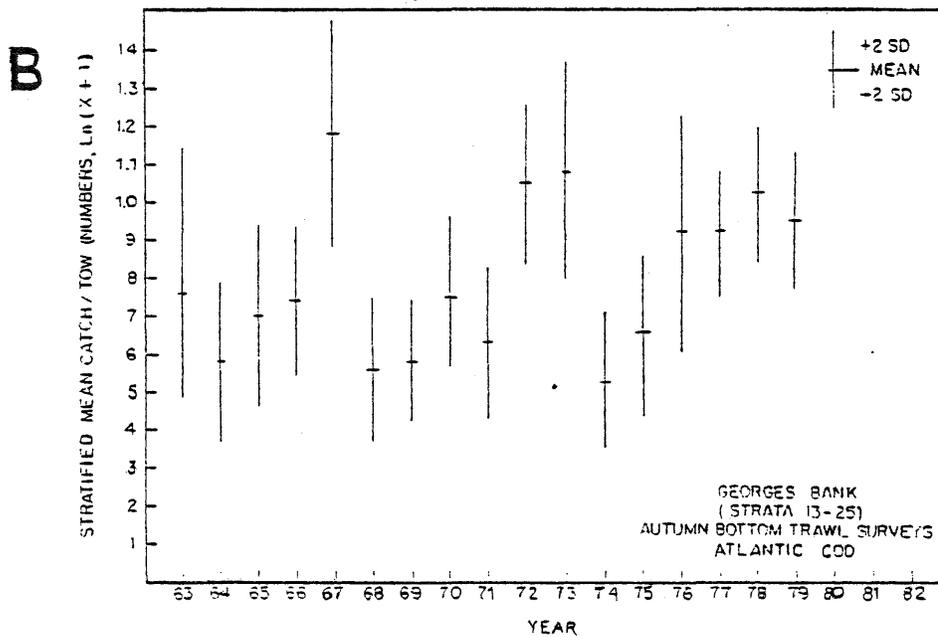
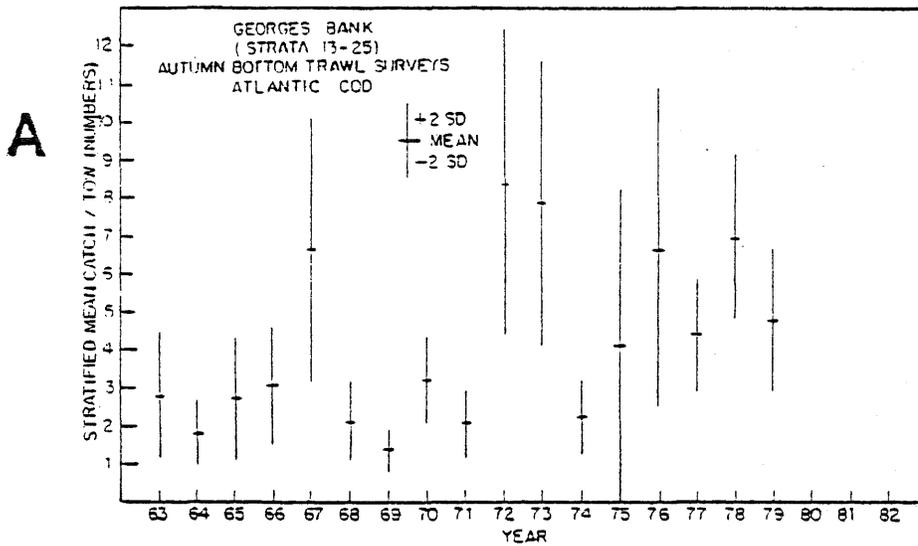


Figure 1. Stratified mean catch (number) per tow of Atlantic cod from NEFC autumn bottom trawl surveys on Georges Bank (Strata 13-25), 1965-1979: (A) linear stratified mean catch per tow; (B)  $\ln(x+1)$  stratified mean catch per tow; and (C) retransformed stratified mean catch per tow.

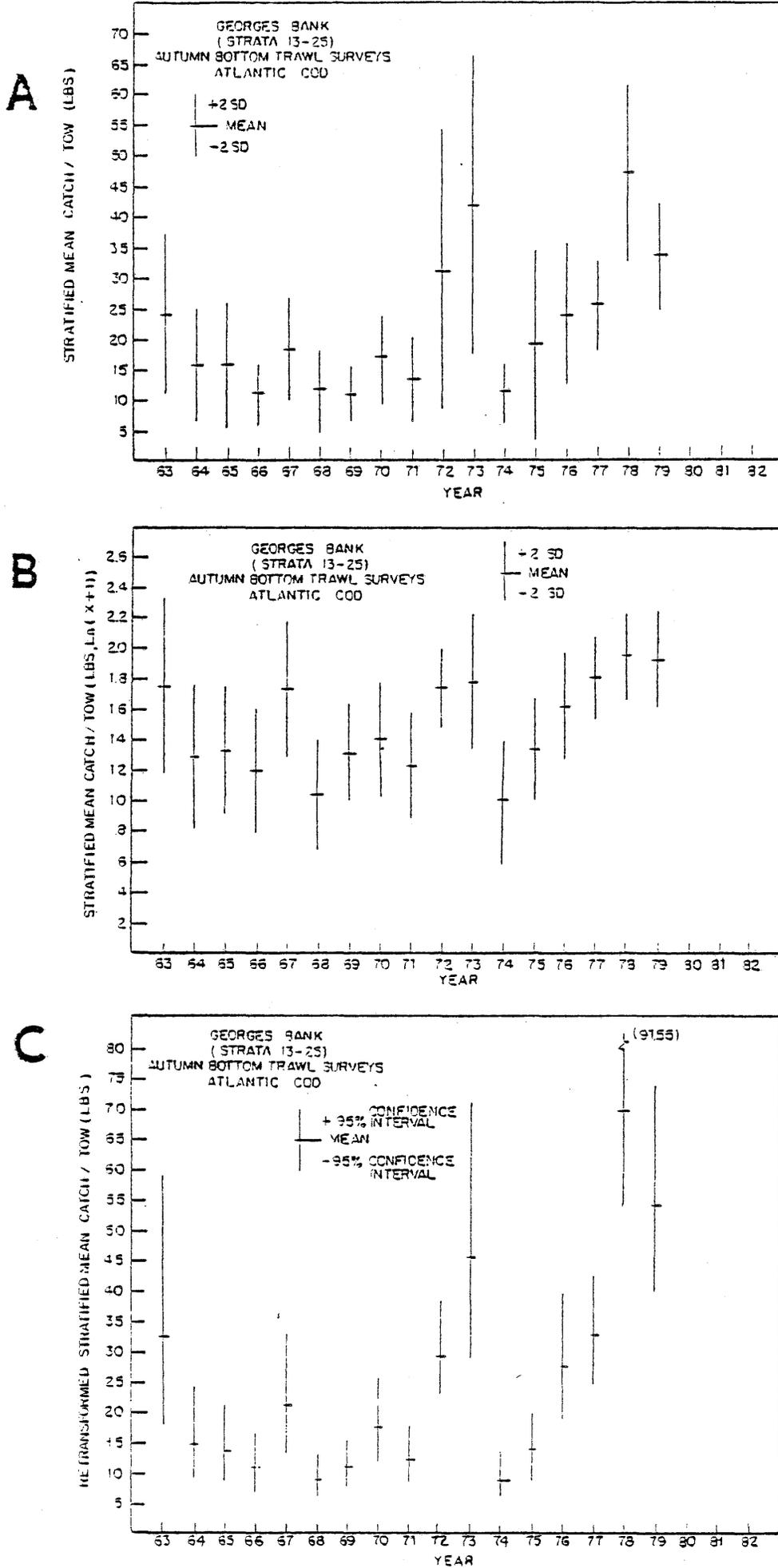


Figure 2. Stratified mean catch (pounds) per tow of Atlantic cod from NEFC autumn bottom trawl surveys on Georges Bank (Strata 13-25), 1963-1979: (A) linear stratified mean catch per tow; (b)  $\ln(x+1)$  stratified mean catch per tow; and (C) retransformed

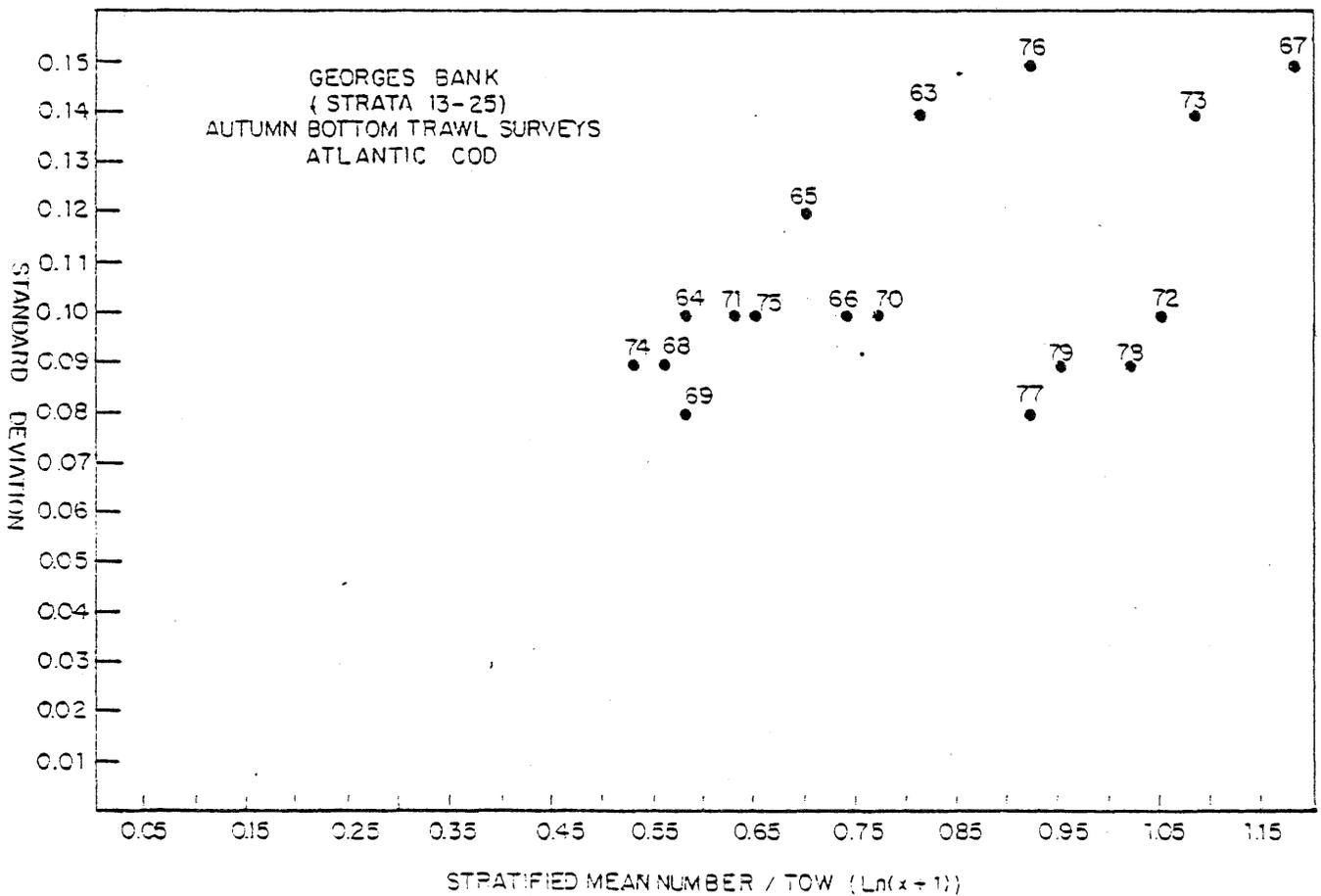
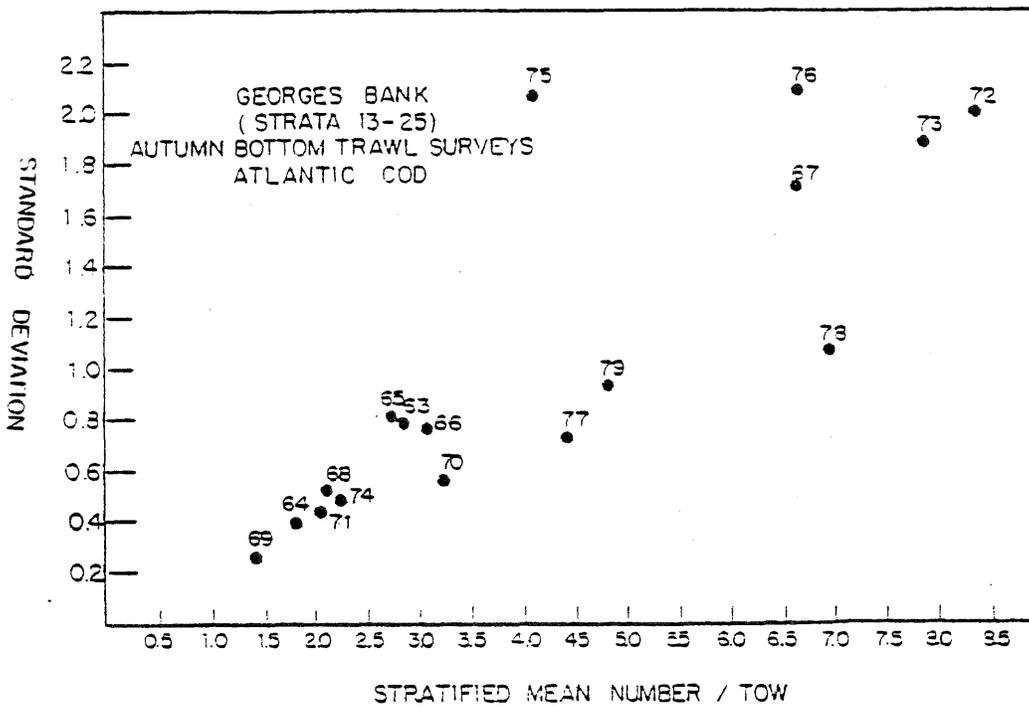


Figure 3. Standard deviation versus stratified mean number per tow for Atlantic cod from NEFC autumn surveys on Georges Bank, 1963-1979: (a) linear scale; and (b)  $\ln(x+1)$  scale.

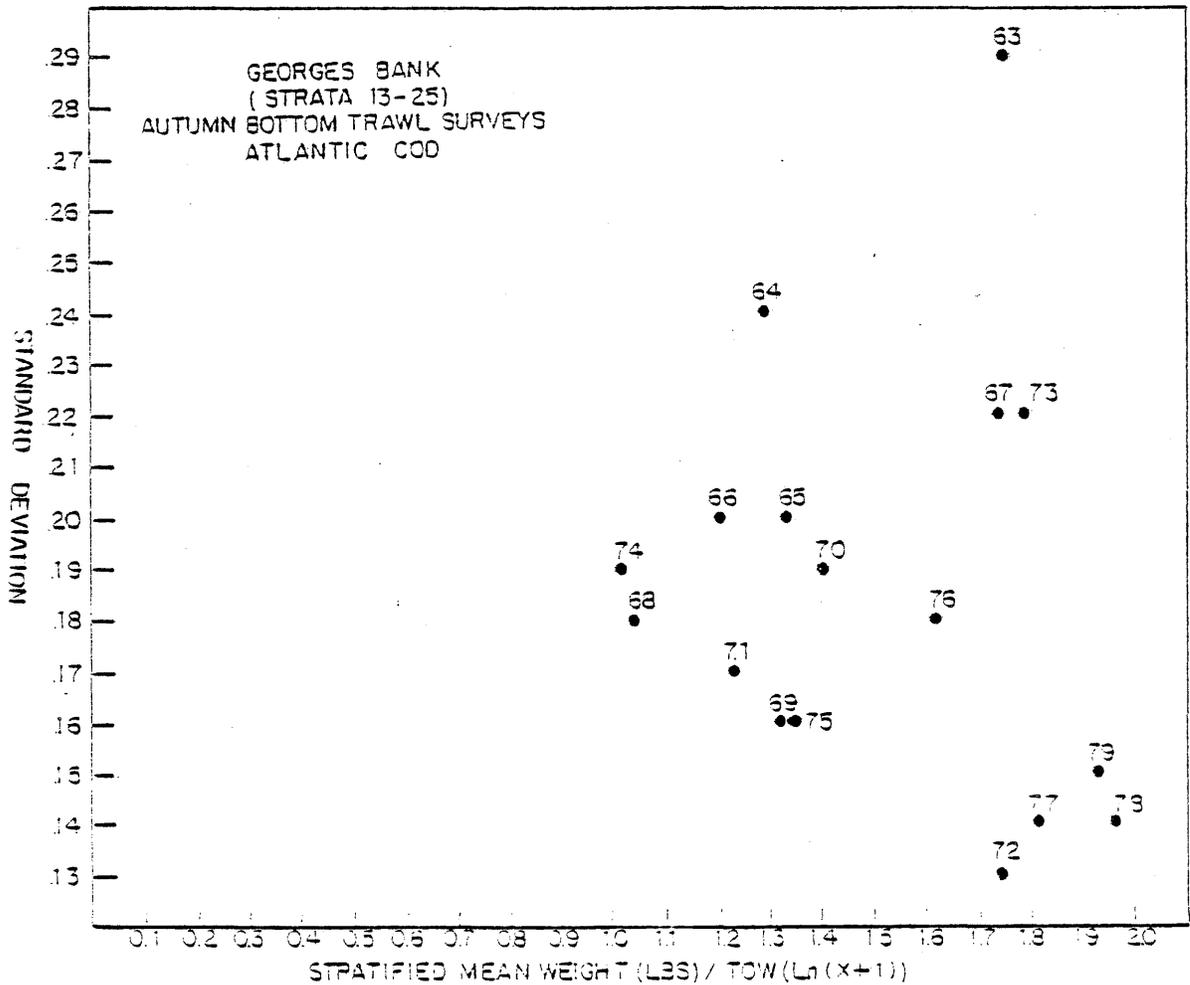
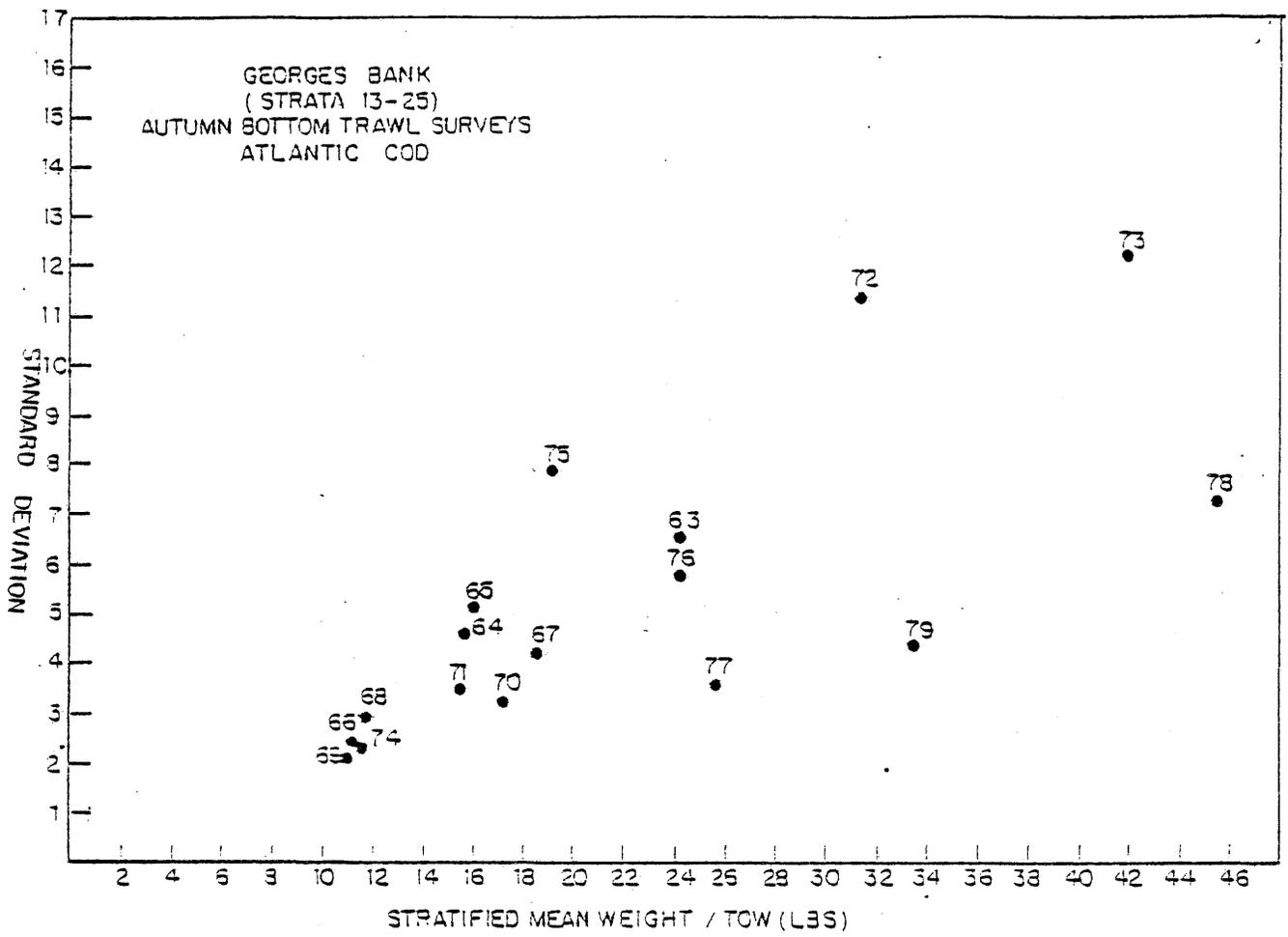


Figure 4. Standard deviation versus stratified mean weight per tow for Atlantic cod from NEEC autumn surveys of Georges Bank, 1963-1979. (a)

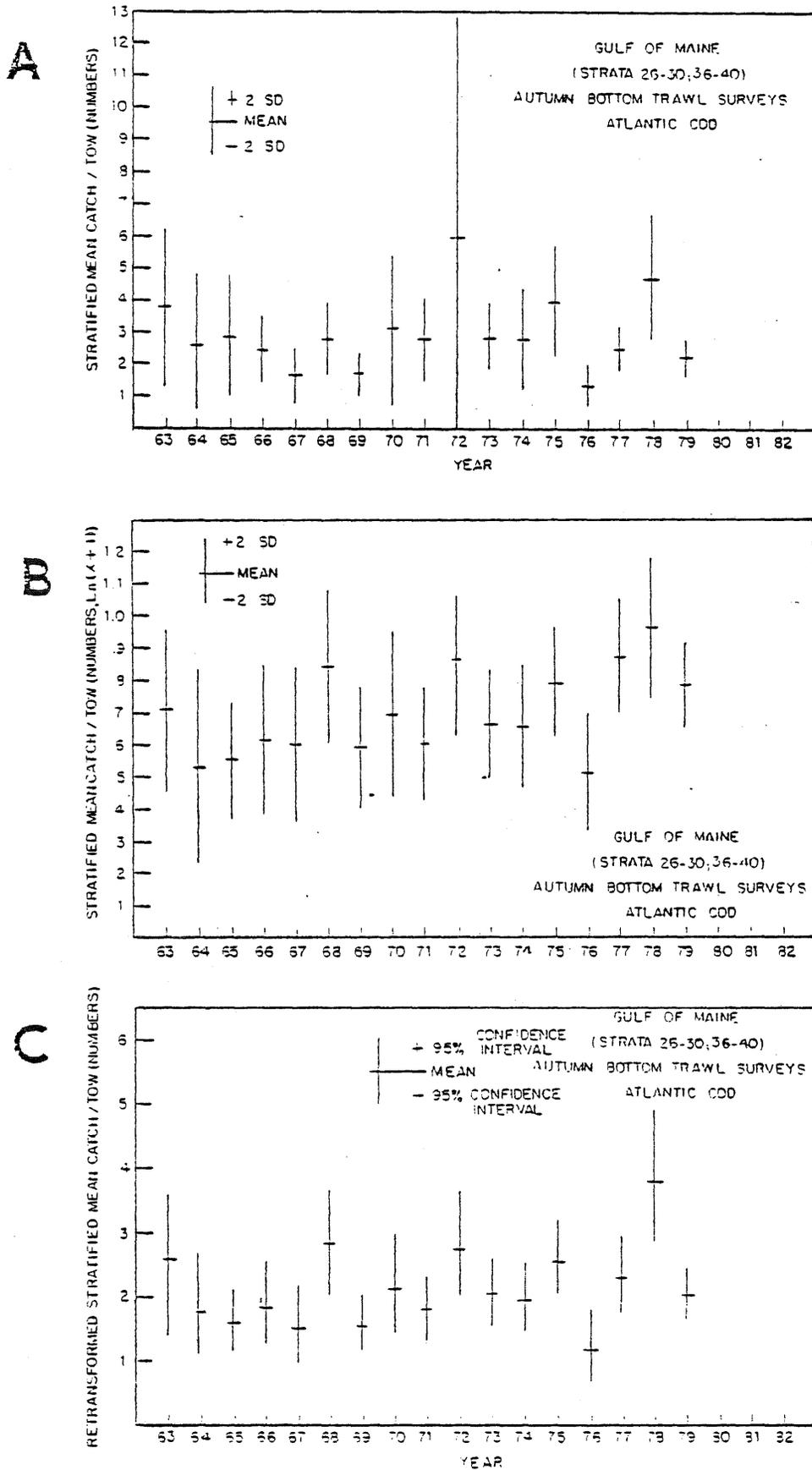


Figure 5. Stratified mean catch (number) per tow of Atlantic cod from NEFC autumn bottom trawl surveys in the Gulf of Maine (strata 26-30; 36-40), 1963-1979: (A) linear stratified mean catch per tow; (B)  $\ln(x+1)$  stratified mean catch per tow; and (C) retransformed mean catch per tow.

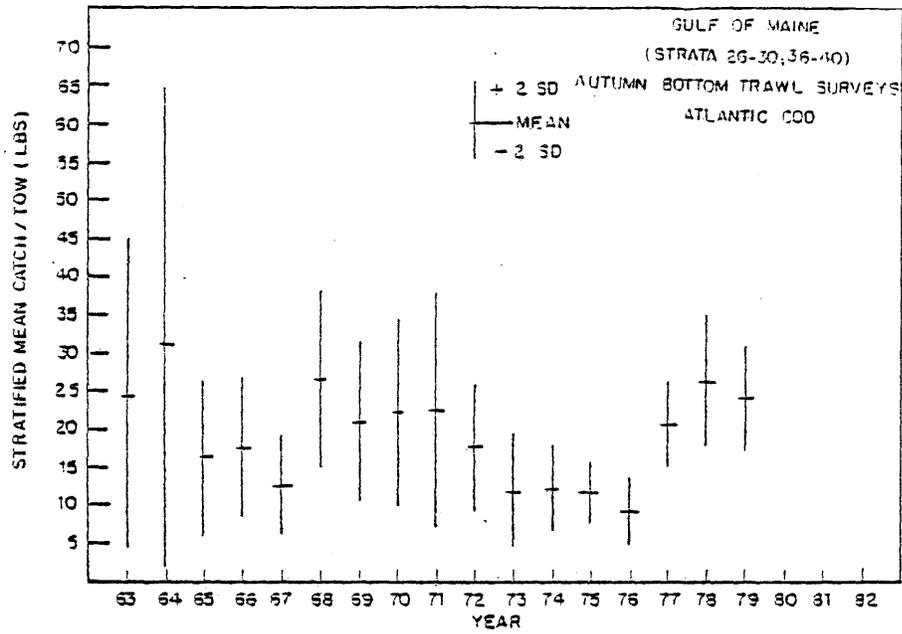
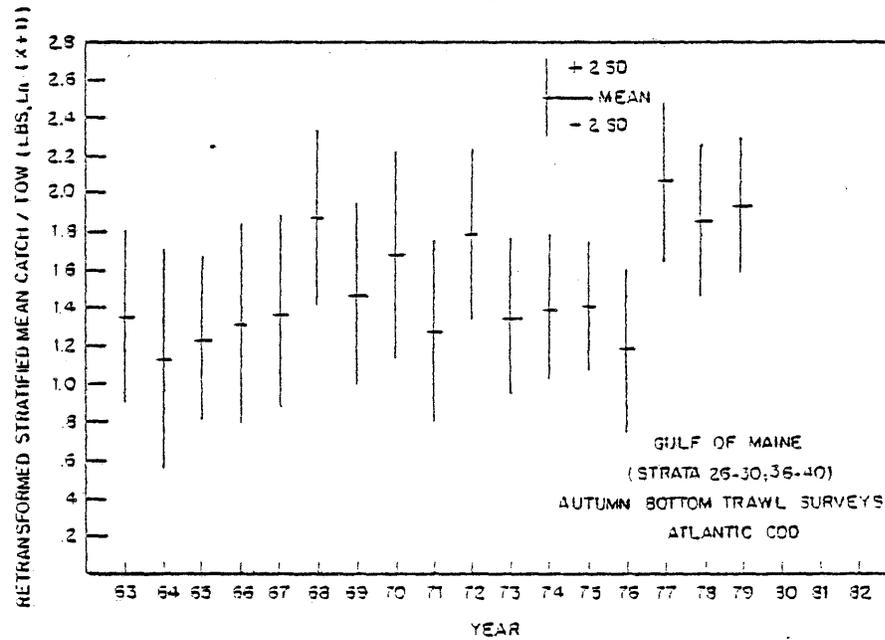
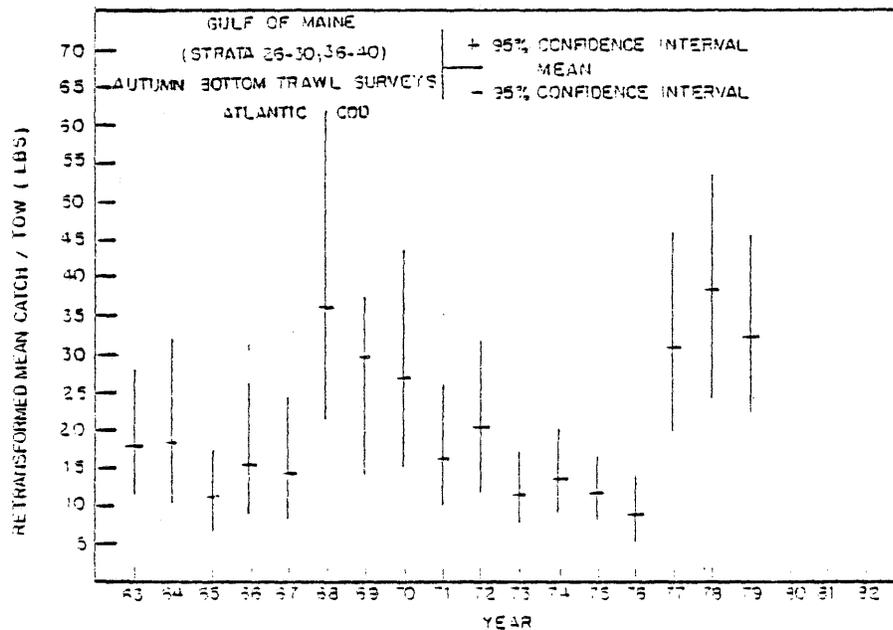
**A****B****C**

Figure 6. Stratified mean catch (pounds) per tow of Atlantic cod from NEFC autumn bottom trawl surveys in the Gulf of Maine (strata 26-30, 36-40), 1965-1979: (A) linear stratified mean catch per tow; (B)  $\ln(x+1)$  stratified mean catch per tow; and (C) retransformed

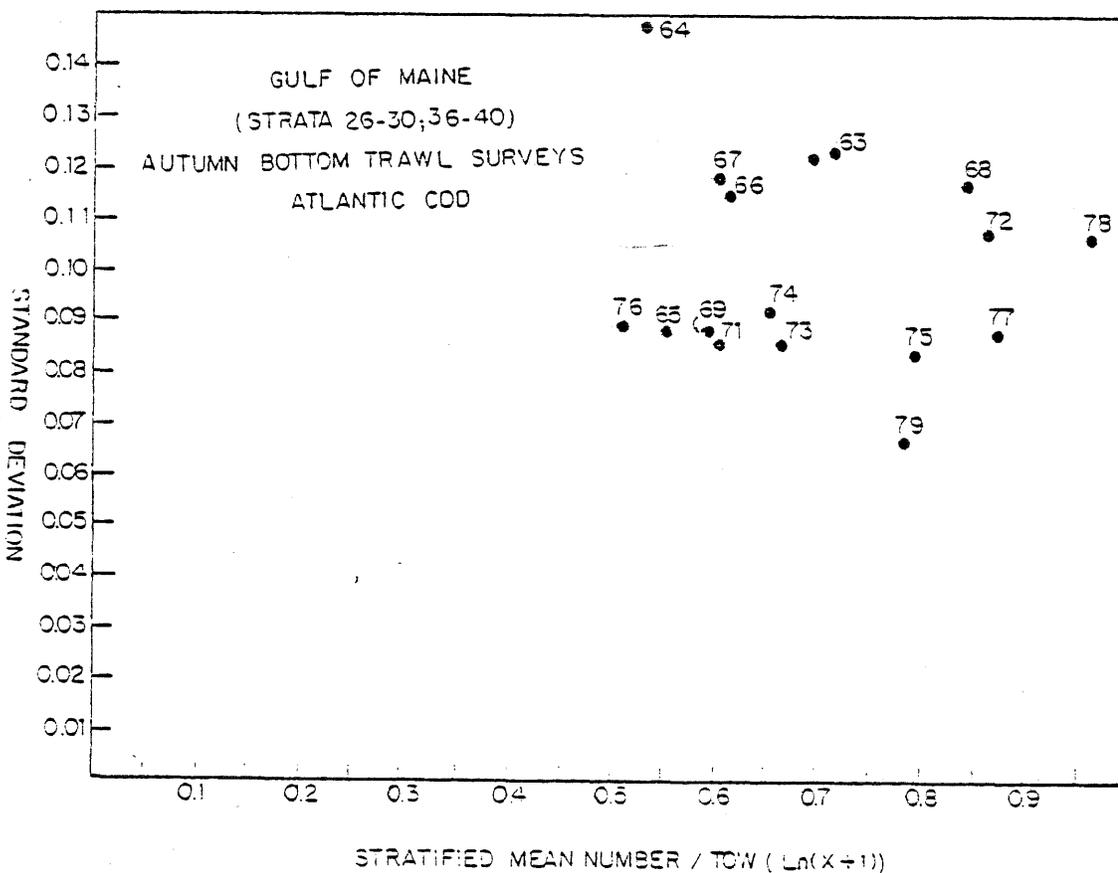
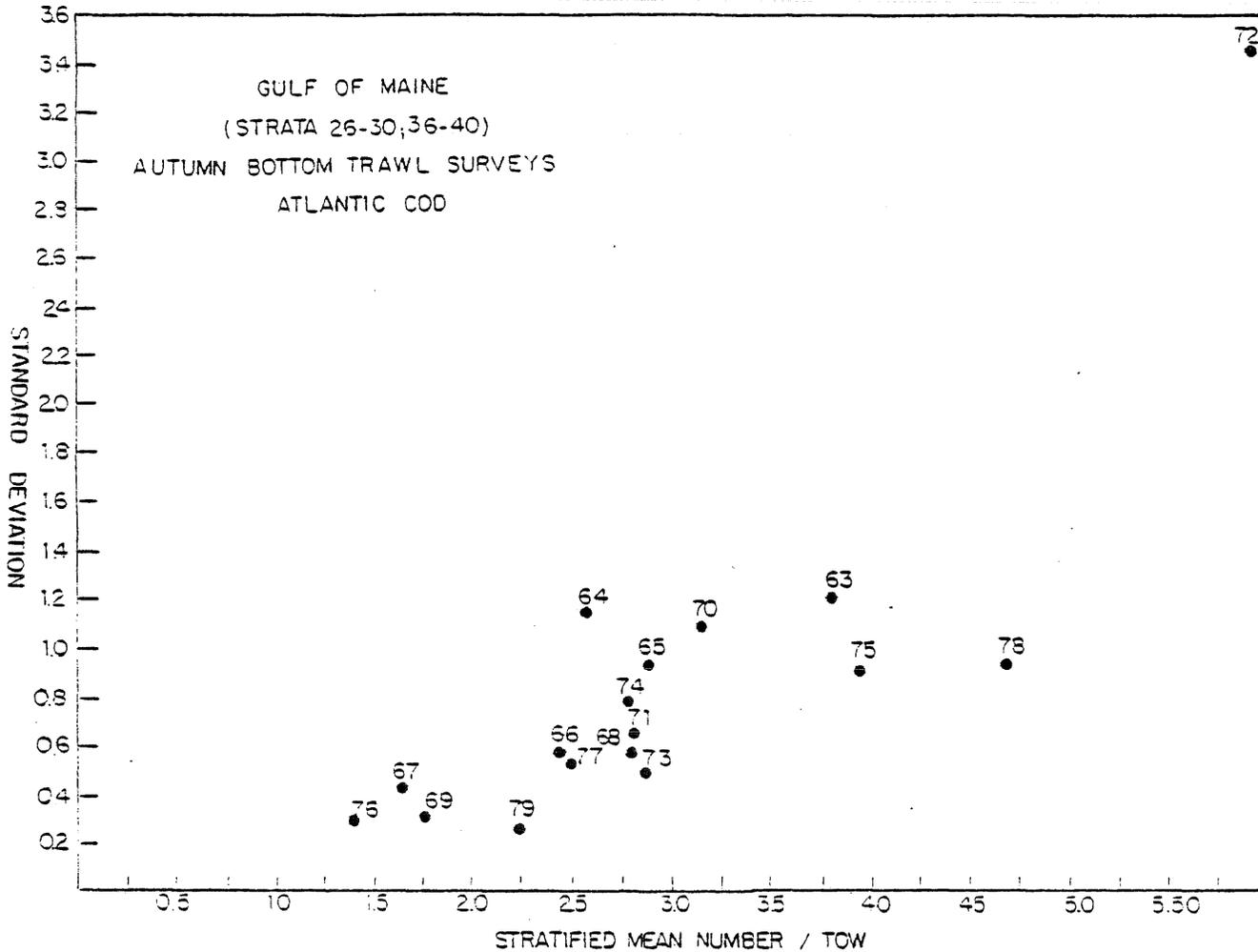


Figure 7. Standard deviation versus stratified mean number per tow for Atlantic cod from NEFC autumn surveys in the Gulf of Maine, 1963-1979: (a) linear scale; and (b)  $\ln(x+1)$  scale.

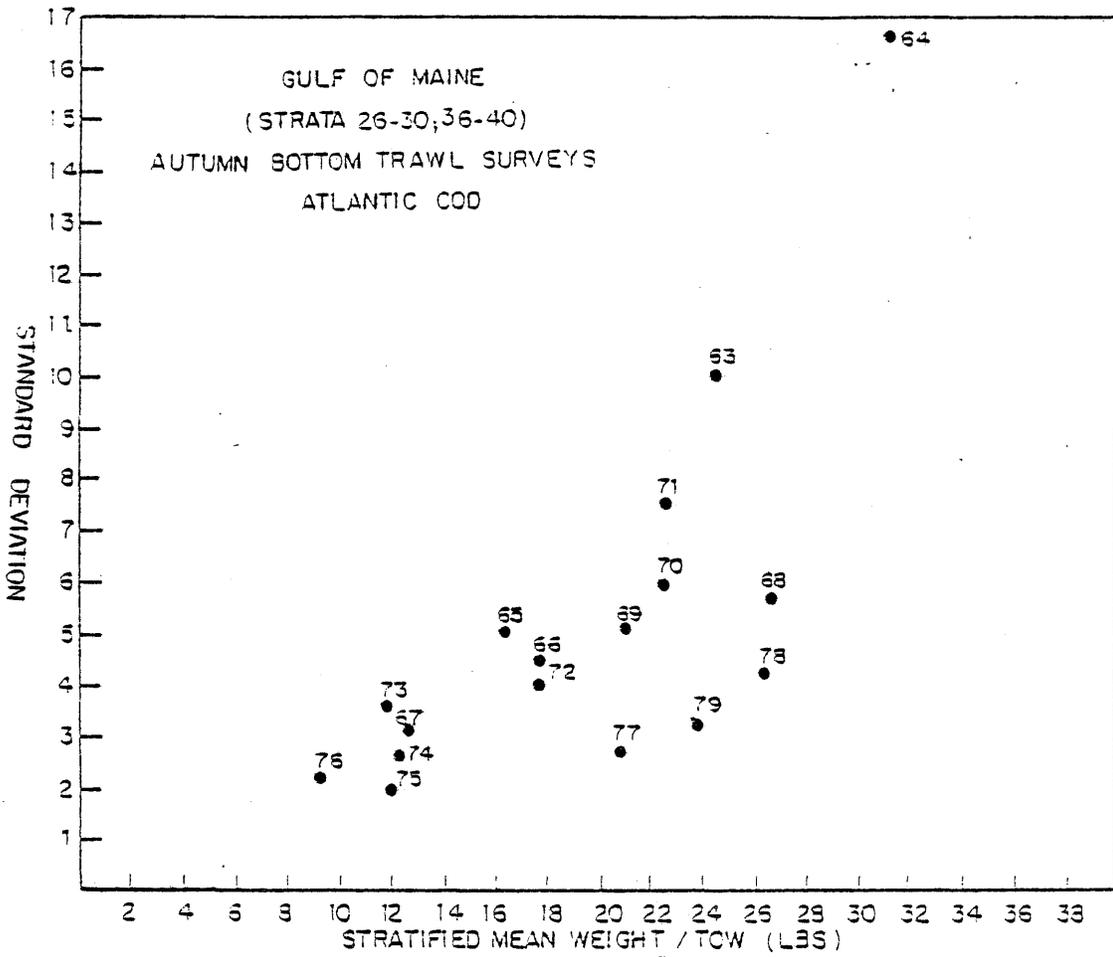
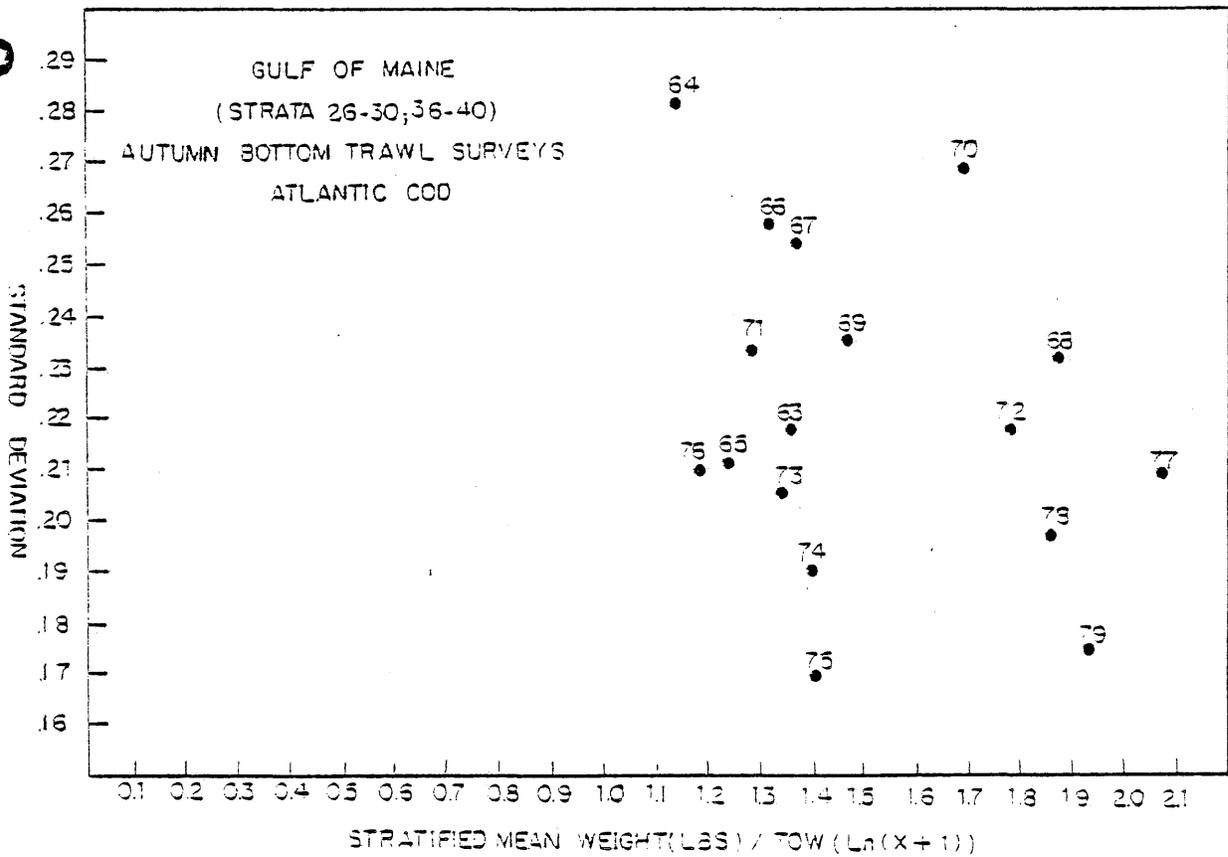
**a****b**

Figure 3. Standard deviation versus stratified mean weight per tow for Atlantic cod from NEFC autumn surveys in the Gulf of Maine, 1963-1979: (a) linear scale; and (b)  $\ln(x+1)$  scale.