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Yellowtail Flounder Assessment Update - 1984

by

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SUMMARY

Commercial landings of yellowtail flounder increased from 15,600 tons in 1981 to 33,100 tons in 1983. Landings for 1984 have declined substantially, however; the projected total is about 18,000 tons. The 1982-1983 increase reflects improved recruitment from the 1979-1981 year classes and relaxation of landings restrictions under the Interim Plan. The 1980 year class predominated in the Southern New England and Georges Bank fisheries in both years. The current decline reflects both reduction of the 1979-1981 year classes by fishing and recruitment of the apparently weak 1982 year class. Dominance of age 2 and age 3 fish in 1982-1983 landings (90% of the total by number) and the magnitude of the current reduction in landings indicates that this fishery is now almost completely dependent upon incoming recruitment.

Commercial catch per unit effort (CPUE) and research vessel survey indices reveal a general increase in abundance and biomass since the mid-1970's, with a generally steeper rise during 1980-1982. Since 1982 indices have declined sharply and in most cases Autumn 1984 values were at or near historic lows. The 1980-1982 increase can be attributed to improved recruitment from the 1979-1981 year classes. The 1980 year class was clearly the strongest of the three and on the Southern New England grounds appears to have been comparable to some of the strong year classes produced during the mid-to-late 1960's. The 1982 and 1983 year classes appear much weaker than the three preceding ones; catches of 1983 year-class fish at age 1 were among the weakest on record for both the Southern New England and Georges Bank grounds, suggesting poor recruitment to the fishery in 1985.

Total mortality (Z) has been very high in recent years. Average estimates of Z for 1980-1983 were 1.30 and 1.05 for Southern New England and Georges Bank yellowtail, respectively, indicating that fishing mortality (F) has been substantially above F_{max} during recent years. Such high levels of mortality imply both significant losses in yield per recruit and depression of spawning stock biomass per recruit to very low levels (<10% of the potential maximum). Discard appears to have been significant in depressing both yield and spawning stock biomass, particularly for Southern New England. Implementation of an increase in minimum codend mesh size to 152 mm (6 inches) would be expected to increase yield and spawning stock biomass per recruit over the long term, but abundance appears to have declined to such low levels that additional measures to control mortality will probably be required if a significant degree of recovery is to be achieved.

INTRODUCTION

The yellowtail flounder (*Limanda ferruginea*) is an important component of the New England fishery resource. Landings have fluctuated considerably over the past two decades, peaking at 57,500 (metric) tons in 1969 and then declining to approximately 11,300 tons in 1978. With improved recruitment during the early 1980's, landings increased to a peak of 33,100 tons in 1983, comparable to levels observed during the early 1970's. Landings have since declined sharply and for the first 10 months of 1984 were 47% below corresponding 1983 levels. This suggests that 1984 landings will approximate 18,000 tons.

Yellowtail populations off Southern New England, on Georges Bank, and off Cape Cod appear to be reasonably distinct although some intermixing has been documented (Royce et al. 1959; Lux 1963). Yellowtail are also fished in the Mid-Atlantic and the Gulf of Maine although landings in these areas have been sporadic. U.S. Statistical Reporting Areas and Northeast Fisheries Center (NEFC) offshore bottom trawl survey strata corresponding to these grounds are indicated in Figures 1 and 2.

Under the Fishery Management Plan (FMP) for Atlantic Groundfish (effective March 15, 1977-March 30, 1982), two management units were established; the Georges Bank (east of 69°W longitude) unit and a second unit (west of 69°W longitude) encompassing the Cape Cod, Southern New England, and Mid-Atlantic grounds (New England Regional Fishery Management Council 1977). Gulf of Maine yellowtail were included in both units by reference to the above boundary line. Management measures implemented under this FMP included optimum yields (OYs) and quota allocations, minimum codend mesh sizes, trip limits, and data reporting requirements.

The Interim Groundfish FMP (effective March 31, 1982) redefined OYs to be the actual harvests by USA fishermen in accordance with other Plan provisions, which included area mesh size regulations, a minimum possession size of 28 cm (11 inches) for yellowtail and a voluntary data reporting system (New England Fishery Management Council 1981). This FMP is scheduled to be replaced by the Atlantic Demersal Finfish (ADF) Plan in 1985.

The purpose of this document is to provide an assessment update for the New England and Mid-Atlantic yellowtail resource based on analyses of commercial landings and interview data and data collected during Northeast Fisheries Center (NEFC) and Massachusetts Division of Marine Fisheries (DMF) bottom trawl surveys. It addresses an abrupt change in resource conditions, i.e., a recent declining trend associated with heavy exploitation and reductions in recruiting year-class size.

COMMERCIAL FISHERY

Nominal catch (live weight equivalent of landings exclusive of discard, hereafter referred to as landings) and total catch data including discard for 1960-1984 are given by area of capture in Table 1; total catches for 1935-1984 are also plotted for the Southern New England, Georges Bank, and Cape Cod areas in Figure 3. Landings for the USA include (1) food fish landings as recorded in NEFC weighout files, annual canvas records, and state bulletins, and (2) landings for industrial purposes as estimated from commercial weighouts and biological sampling. The latter were taken primarily off Southern New England during the mid-to-late 1960's; industrial landings have been negligible since 1973. Landings by foreign

nationals are as reported to the International Commission for the Northwest Atlantic Fisheries (ICNAF) and the Northwest Atlantic Fisheries Organization (NAFO) or as estimated previously (Brown and Hennemuth MS 1971).

Discard estimates for 1963-1977 and 1983 were obtained directly from USA dockside interviews; estimates for years prior to 1963 are as reported by Brown and Hennemuth (MS 1971). Since interview data for 1978-1982 are limited, estimates for these years were derived from research vessel survey and gear selectivity data (Clark et al. MS 1981; Mayo et al. MS 1981; McBride and Clark MS 1983). It should be noted that USA landings and discard data for 1979 through the first quarter of 1982 are not considered reliable due to alleged misreporting (or nonreporting) to circumvent landings restrictions imposed under the Atlantic Groundfish FMP.

Age compositions for USA Southern New England and Georges Bank yellowtail landings were estimated using reported landings data and length frequencies and age samples derived from dockside sampling by NMFS port agents. Age-length keys were prepared for each quarter and applied to corresponding length frequency expansions. Results were summarized by year to provide annual age compositions which are reported for 1970-1983 in terms of percent landed at age (Table 2). Royce et al. (1959), Brown and Hennemuth (MS 1971), and McBride and Clark (MS 1983) have provided age composition data for commercial landings and discard for earlier years.

Distinct peaks in total catch are evident for the Southern New England grounds during the 1940's and 1960's (Figure 3). The fishery collapsed during the early-to-mid-1970's, after which reported annual landings increased to an annual average of 5,400 tons during 1979-1981.

Under the Interim Plan, landings increased to 10,300 tons in 1982 and to 17,500 tons in 1983. Landings have since declined sharply; the projected 1984 total is 8,800 tons, 50% below the 1983 figure (Table 1).

Age composition data (Table 2) reveal that the 1982-1983 increase largely resulted from recruitment of the 1980 year class (which accounted for 57 and 66 percent, respectively, of the landings by number). The 1979 and 1981 year classes also contributed appreciably. The 1983 peak in landings thus appears to have resulted primarily from improved recruitment, although relaxation of landings restrictions under the Interim Plan was also a factor (McBride and Clark MS 1983). The 1984 decline appears to reflect reductions of the above year classes by fishing and recruitment of a much weaker 1982 year class (discussed further below).

Commercial catches from Georges Bank fluctuated about an average of 18,000 tons from the mid-1960's to the early 1970's and then declined to only 5,000 tons in 1978 (Figure 3). Subsequently, landings increased to an annual average of 11,000 tons during 1982-1983, but have again declined sharply during the current year. The projected 1984 total is 5,700 tons, 50% below the 1983 total of 11,400 tons (Table 1). Again, the 1982-1983 increase largely reflects improved recruitment from the 1979-1981 year classes with the 1980 year class predominating (50% and 60% of total landings by number in 1982 and 1983, respectively, see Table 2).

Historical catches from the Cape Cod grounds have generally fluctuated about a relatively constant level (Figure 3). Annual landings rose from about 2,000 tons in 1974-1975 to over 5,000 tons in 1980 (Table 1). This appears to reflect improving resource conditions as noted for other areas. Since 1980 landings have declined substantially, i.e., from an average of 3,200 tons during 1981-1982 to a projected total of 1,000 tons for 1984.

Landings for the Mid-Atlantic grounds peaked during 1972 and then declined to minimal levels during the late 1970's. Recent landings have increased sharply; the 1983 total was 2,000 tons, and preliminary data for 1984 suggest a total of perhaps 2,400 tons (Table 1). This increase appears to reflect both redirection of effort from the Southern New England grounds and increased effort by southern vessels fishing largely in Statistical Area 613 (Figure 1)[1]. Since NEFC surveys indicate a sharp decline in abundance for the Mid-Atlantic during 1982-1984 (discussed below), a substantial increase in fishing mortality is implied. Landings for the Gulf of Maine increased to an average of about 500 tons during 1980-1982 and have since declined (Table 1).

INDICES OF ABUNDANCE

Commercial catch per unit effort (CPUE) indices have been calculated for domestic trawlers using trip data for vessels of 5-104 gross tons (GT) for which at least 50% of the total catch by weight consisted of yellowtail flounder (Lux 1964). These calculations involved standardization of fishing effort by applying fishing power coefficients (originally obtained by Lux) to summarized vessel class effort data (days fished) using 26-50 GT vessels as the standard. Adjusted effort data were then summed over vessel classes and divided into corresponding landings and discard data to obtain CPUE indices (catch per day fished in metric tons) for the Southern New England, Georges Bank, and Cape Cod grounds (Table 3, Figure 4).

The NEFC has conducted stratified random bottom trawl surveys in offshore waters (>27 m) in spring and autumn since the 1960's and in inshore

[1] Jay David, Rhode Island Department of Environmental Management, Newport, Rhode Island, pers. comm. December 1984.

areas (<27 m) since 1972. A "36 Yankee" trawl has been used in all autumn surveys and in all spring surveys except during 1973-1981 when a modified high-opening "41 Yankee" trawl was used. Both trawls are equipped with roller gear and 1.25 cm (0.5 inch) codend liners. Conversion factors have been applied to spring survey catch-per-tow data as necessary to adjust for differences in fishing power between these trawls (Sissenwine and Bowman 1978). Further information on NEFC survey design and procedures and application of resulting data to yellowtail assessments is provided by Azarovitz (1981), Clark (1982), and McBride and Clark (MS 1983). Inshore surveys by the Massachusetts Division of Marine Fisheries (DMF) (see Howe et al. 1984 and earlier DMF reports) have also provided a useful time series for the Cape Cod grounds. Indices of abundance and biomass (stratified mean catch per tow in numbers and weight in kilograms, kg) have been developed for NEFC offshore and Massachusetts DMF spring and autumn surveys (Tables 4-8 and Figure 5). Results from summer and inshore surveys prior to 1984 are given by McBride and Clark (MS 1983). In all cases these have corroborated results obtained from NEFC spring and autumn offshore surveys.

Southern New England

Commercial CPUE (Table 3, Figure 4) and NEFC survey results (Table 4, Figure 5) indicate a pronounced decline in abundance to very low levels from the late 1960's to the mid-1970's, followed by gradual recovery and then a sharp increase during the early 1980's. NEFC survey indices of abundance (Table 4) more than tripled from 1979-1982, while commercial CPUE almost doubled (Table 3). This increase resulted primarily from recruitment of the 1979-1981 year classes, with the 1980 year class being

the strongest of the three; in fact, survey catch per tow at age indicate this year class to have been comparable to some of the strong year classes produced during the mid-to-late 1960's (Table 4). Reduction of this year class by intensive fishing, together with the appearance of the weak 1982 and 1983 year classes, has resulted in a substantial reduction in abundance since 1982. Catches of 1983 year class fish at age 1 are among the lowest age 1 catches observed in either the spring or the autumn surveys, suggesting very poor recruitment to the Southern New England grounds during 1985.

Georges Bank

Data for Georges Bank are conflicting and more difficult to interpret. Commercial CPUE and NEFC spring surveys suggest a modest increase in abundance during 1977-1982, while autumn survey indices fluctuated without a definite trend (Tables 3 and 5, Figure 5). The sharp increase in 1980 (Table 5) appears to have resulted primarily from changes in availability since catch-at-age values increased for several fully recruited year classes (Table 5). Since 1982, commercial CPUE has remained constant, but spring and autumn survey indices have declined substantially. Again, the 1979-1981 year classes appear to have predominated in recent years, with the 1980 year class being the strongest of the three. The 1982 and 1983 year classes appear to be among the weakest observed in the history of these surveys (Table 5).

Cape Cod

Commercial CPUE for the Cape Cod grounds has increased slightly since the mid-1970's although since 1978 values have been virtually identical (Table 3, Figure 4). NEFC survey indices (Table 6) suggest increased

abundance during 1980-1982 as compared to the late 1970's, primarily due to improved recruitment from the 1979 and 1980 year classes (McBride and Clark MS 1983). Abundance has declined substantially since 1982 although data for autumn are less consistent. The 1982 and 1983 year classes again appear extremely weak.

Indices have also been developed for Cape Cod yellowtail from Massachusetts DMF inshore survey data for Regions 3, 4, and 5 (Figure 6). Indices for 1978-1982 fluctuated without a definite trend, but have since declined substantially. There is no clear evidence for a strong 1980 year class in these data (Table 7).

Mid-Atlantic

Trends for the Mid-Atlantic area have been very similar to those observed for Southern New England. NEFC survey abundance indices declined to very low levels in the mid-1970's, improved slightly during the late 1970's and then rose sharply during 1981-1982; since 1982, abundance has markedly declined (Table 8, Figure 5). The 1979-1981 year classes were the strongest to appear in recent years with the 1979 and 1980 year classes being the most prominent (McBride and Clark MS 1983). More recent year classes appear to be poor.

To summarize, commercial CPUE and research vessel survey results indicate a general decline in abundance to very low levels during the mid-1970's, followed by modest to substantial improvement into the 1980's with improved recruitment from the 1979-1981 year classes. With subsequent reduction of these year classes by fishing and poor recruitment from the 1982 and 1983 year classes, abundance has again declined sharply, and prospects for 1985 appear bleak. There is, as yet, no indication of the relative strength of the 1984 year class which will recruit to the fishery in 1986.

MORTALITY

Estimates of instantaneous total mortality (Z) for recent years were obtained from both commercial CPUE and NEFC research vessel survey catch-per-tow-at-age data for the Southern New England and Georges Bank grounds. For commercial data, percentage values in Table 2 were applied to total landings in numbers to generate estimated total landings at age; these were divided by the corresponding days fished values in Table 3 to provide CPUE at age. Estimates of Z were then calculated for fully recruited age groups (age 3+) for 1977-1983 and 1980-1983 using the relationships

$$Z = \ln \left[\frac{\Sigma \text{ Age } 3+ \ 1977\text{-}1982}{\Sigma \text{ Age } 4+ \ 1978\text{-}1983}\right]$$

and $$Z = \ln \left[\frac{\Sigma \text{ Age } 3+ \ 1980\text{-}1982}{\Sigma \text{ Age } 4+ \ 1981\text{-}1983}\right]$$

Discard estimates were not included in these calculations, but since the above summations included CPUE values for fully recruited age groups only, resulting bias should be minimal. (Omission of discard data would tend to bias Z estimates downwards since data for younger age groups would be most affected.) The reliability of catch and effort data for 1979-1981 is also somewhat questionable, and the amount and direction of bias from this source of error is unknown. Resulting estimates of Z were as follows:

	Southern New England	Georges Bank
1977-1983	1.24	1.03
1980-1983	1.44	1.01

Estimates of Z were also calculated from NEFC survey catch per tow at age (Tables 4 and 5) using the following relationships:

SPRING	AUTUMN
$Z = \ln \left[\frac{\Sigma \text{ Age } 3+ \ 1977\text{-}1983}{\Sigma \text{ Age } 4+ \ 1978\text{-}1984}\right]$	$Z = \ln \left[\frac{\Sigma \text{ Age } 2+ \ 1976\text{-}1982}{\Sigma \text{ Age } 3+ \ 1977\text{-}1983}\right]$
and $Z = \ln \left[\frac{\Sigma \text{ Age } 3+ \ 1980\text{-}1983}{\Sigma \text{ Age } 4+ \ 1981\text{-}1984}\right]$	$Z = \ln \left[\frac{\Sigma \text{ Age } 2+ \ 1979\text{-}1982}{\Sigma \text{ Age } 3+ \ 1980\text{-}1983}\right]$

These data have not been biased by discard or reporting uncertainties; therefore, results would appear more reliable. Calculated Z values are as follows:

	Southern New England		Georges Bank	
	Spring	Autumn	Spring	Autumn[2]
1977-1983	1.26	1.08	1.32	0.82
1980-1983	1.53	1.00	1.44	0.79

With the exception of autumn survey estimates for Georges Bank, calculated Z values equal or exceed 1.0 and substantially so in some cases. A general tendency is evident both for higher mortality off Southern New England and for higher mortality rates in recent years. The lower Z values calculated from autumn survey data may reflect incomplete recruitment to the survey gear in autumn at age 2. Estimates developed from commercial data were in all cases intermediate between corresponding values developed from spring and autumn survey data.

For Southern New England yellowtail, averaged estimates of Z (all data sources) were 1.19 and 1.30, respectively, for 1977-1983 and 1980-1983. Corresponding averages for Georges Bank yellowtail were somewhat lower (1.04 and 1.05, respectively). Assuming instantaneous natural mortality (M) = 0.2 for yellowtail (Lux 1969), then F has been at or above 1.0 for

[2]Since results appeared to be biased appreciably by availability changes in 1980 (Table 5), data for that year were not included in the calculations.

Southern New England and 0.8 for Georges Bank in recent years, in both cases substantially above F_{max} = 0.5 for these groups. Estimates are higher than those obtained by Lux (1969) for Southern New England yellowtail from analysis of commercial CPUE data for 1960-1965 (Z = 1.03), but compare favorably with those for Georges Bank (Z = 1.02). These values also agree well with estimates obtained by Penttila and Brown (1973) from analyses of research vessel survey data for 1963-1969 (Z = 1.25 and 1.00 for Southern New England and Georges Bank yellowtail, respectively).

YIELD AND SPAWNING STOCK BIOMASS PER RECRUIT

Yield and spawning stock biomass per recruit calculations were performed to further evaluate the implications of recent fishing patterns and fishing mortality levels. Here the Southern New England situation was of primary interest as substantial portions of these grounds lie outside the Interim Plan large mesh area, implying a smaller effective mesh size than for the Georges Bank or Cape Cod grounds. The current draft of the ADF includes a provision to extend the large mesh area westward to 71°W longitude, thereby encompassing most of the Southern New England grounds, and to raise minimum codend mesh size within the redefined area to 152 mm (6 inches) one year after Plan implementation.

Discard impacts are of particular interest for Southern New England yellowtail, as such losses may be considerable. Discard estimates for 1982 and 1983 (Table 1) and age composition and mean weight-at-age data from research vessel surveys for the assumed discard range (Mayo et al. MS 1981) suggest that in any given year discard may equal 50% and 10% or more, respectively, of total numbers landed at ages 2 and 3. These

estimates are probably conservative since they assume use of 130 mm (5-1/8 inch) codends which are currently not mandatory west of 70°W longitude. During the third quarter of 1982 (when the strong 1980 year class was recruiting to the fishery), discard on a per-trip basis ranged from 25-80% of the landed total by weight (McBride and Clark MS 1983).

To account for discard mortality, we incorporated a term for discard into the Thompson and Bell (1934) model assuming knife-edge recruitment, viz.

$$Y = \sum_{i=a}^{n} W_i N_i \frac{F_i}{F_i+M+D_i}(1-e^{-(F_i+M+D_i)})$$

where a = age of the youngest age group;

n = age of the oldest age group;

W_i = weight at age i;

N_i = number at age i;

F_i = instantaneous fishing mortality at age i;

M = instantaneous natural mortality rate, and

D_i = discard mortality, applied only at ages 2 and 3.

Growth, mortality, and maturation data were the same as used by Gabriel et al. (MS 1984) and where discard factors were not used, results were the same. Discard adjustments were applied only for a mean age at recruitment (t_c) of 2 years as t_c values of 3 years or higher imply an increase in mean selection length to above the reported average cull size (Mayo et al. 1981). Three discard options were simulated, these being zero and zero, 25% and 5%, and 50% and 10% of landings by number for ages 2 and 3, respectively. This was done by setting D_2 and D_3 equal to the corresponding fractional values of F_2 and F_3 within each option.

Results of these analyses (Figure 7) demonstrate considerable potential benefits associated with reductions in fishing mortality and/or increases in t_c even without adjustments for discard, e.g., raising t_c from 2 to 3 years and reducing F from current levels (∿1.0) to 0.7 or so results in a 27% increase in yield per recruit and an increase of 150% in spawning stock biomass, i.e., from less than 10% to over 20% of the maximum (Figure 7). Yield declines considerably with increasing discard, particularly at higher F levels (Figure 7). Increasing t_c from 2 to 3 years and reducing F from 1.0 to 0.7 results in an increase in yield of over 80% under the maximum discard option. The associated increase in spawning stock biomass is over 200% (Figure 7). These results do not appear unreasonable since increased catches which are discarded in effect remove individuals from the catch and the population both immediately and in subsequent years.

The above analyses are not intended to be definitive, as the precise amount and age composition of the yellowtail discard off Southern New England is unknown and total mortality levels at age 2 are uncertain. Levels assumed appear realistic based on historical trends and recent events in this fishery. Implementation of a minimum mesh size of 152 mm (6 inches) as proposed under the current draft version of ADF for Georges Bank and Southern New England implies an increase in t_c to about 3.1 years (and an increase in spawning stock biomass to perhaps 20% of the possible maximum). Gains in yield and spawning stock biomass will obviously be greater if F can be reduced to reasonable levels, i.e., F_{max} or below. Conversely, the 20% target level might not be achieved in practice even with the above increase in mesh size if large numbers of yellowtail continue to be discarded and mortality on fully recruited fish remains high.

CONCLUSIONS

Recent events in the yellowtail flounder fishery reflect the cumulative effects of sustained high levels of fishing mortality (including a less quantifiable, but obviously high discard component at age 2) and deteriorating recruitment. Recruitment of the strong 1980 year class and removal of catch limitations under the Interim Plan resulted in an increase in landings to 25,000 tons in 1982 and to 33,000 tons in 1983, the highest seen in a decade. Landings have since dropped sharply; the projected 1984 total is about 18,000 tons. Landings in number in 1982 and 1983 were dominated by age 2 and age 3 fish (90% of the total over both years). Fishing mortality estimates for Southern New England and Georges Bank are among the highest observed for New England finfish stocks and, if anything, appear to have increased in recent years. Since 1982, NEFC survey indices have markedly declined and in most cases are at or near the lowest ever observed. The 1982 and 1983 year classes which would primarily support the 1985 fishery at ages 3 and 2, respectively, appear to be among the weakest on record. The above data indicate a rapid deterioration in resource conditions within the past two years. Given that abundance in all areas is at or near historic lows and recruitment prospects are extremely poor, yields should continue to decline in the immediate future. Yield and spawning stock biomass per recruit analyses for Southern New England yellowtail indicate that much higher levels of yield and spawning stock biomass can be achieved by raising mesh size, although given the current depressed state of yellowtail and poor recruitment prospects, more direct controls on mortality will probably be necessary to effect significant improvements.

The recent World Court decision transferring jurisdiction over the Northern Edge-Northeast Peak region of Georges Bank to Canada is expected to result in a comparatively minor reduction in availability of yellowtail to the U.S. fishery, e.g., during 1981-1983 only 5% of the total harvest by USA vessels came from that area. Impacts on the remainder of the resource associated with transfer of USA groundfish effort to other portions of Georges Bank and the Southern New England and Cape Cod grounds could be much more significant.

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Table 1. Commercial catch of yellowtail flounder (000's of metric tons) from the Southern New England, Georges Bank, Cape Cod, Mid-Atlantic, and Gulf of Maine areas[1], 1960-1984.

	Southern New England					Georges Bank					Cape Cod				
	Nominal Catch[2]			Estimated[3] USA	Total	Nominal Catch			Estimated USA	Total	Nominal Catch			Estimated USA	Total
Year	USA	Foreign[4]	Total	Discard	Catch	USA	Foreign	Total	Discard	Catch	USA	Foreign	Total	Discard	Catch
1960	8.3	-	8.3	3.2	11.5	4.4	-	4.4	1.5	5.9	1.5	-	1.5	0.5	2.0
1961	12.3	-	12.3	4.7	17.0	4.2	-	4.2	1.5	5.7	1.8	-	1.8	0.6	2.4
1962	13.3	-	13.3	5.3	18.6	7.7	-	7.7	2.7	10.4	1.9	-	1.9	0.6	2.5
1963	22.3	0.2	22.5	5.4	27.9	11.0	0.1	11.1	5.6	16.7	3.6	-	3.6	1.0	4.6
1964	19.5	-	19.5	9.5	29.0	14.9	-	14.9	4.9	19.8	1.8	-	1.8	0.6	2.4
1965	19.4	1.4	20.8	7.0	27.8	14.2	0.8	15.0	4.4	19.4	1.5	-	1.5	0.5	2.0
1966	17.6	0.7	18.3	5.3	23.6	11.3	0.3	11.6	2.1	13.7	1.8	-	1.8	0.3	2.1
1967	15.3	2.8	18.1	7.7	25.8	8.4	1.4	9.8	5.5	15.3	1.5	-	1.5	0.8	2.3
1968	18.2	3.5	21.7	6.3	28.0	12.8	1.8	14.6	3.6	18.2	1.6	-	1.6	0.6	2.2
1969	15.6	17.6	33.2	2.4	35.6	15.9	2.4	18.3	2.6	20.9	1.3	-	1.3	0.3	1.6
1970	15.2	2.5	17.7	4.7	22.4	15.5	0.3	15.8	5.5	21.3	1.2	-	1.2	0.4	1.6
1971	8.6	0.3	8.9	3.3	12.2	11.9	0.5	12.4	3.1	15.5	1.7	-	1.7	0.7	2.4
1972	8.5	3.0	11.5	1.7	13.2	14.2	2.2	16.4	1.2	17.6	1.4	-	1.4	0.3	1.7
1973	7.5	0.2	7.7	0.1	7.8	15.9	0.3	16.2	0.6	16.8	1.7	-	1.7	<0.1	1.7
1974	6.4	0.1	6.5	0.7	7.2	14.6	1.0	15.6	1.2	16.8	2.1	-	2.1	0.2	2.3
1975	3.2	-	3.2	0.2	3.4	13.8	0.1	13.9	1.0	14.9	2.0	-	2.0	<0.1	2.0
1976	1.6	<0.1	1.6	0.2	1.8	11.4	<0.1	11.4	0.7	12.1	3.6	-	3.6	0.1	3.7
1977	2.8	<0.1	2.8	<0.1	2.8	9.5	-	9.5	0.2	9.7	3.5	-	3.5	<0.1	3.5
1978	2.3	-	2.3	0.3	2.6	4.5	<0.1	4.5	0.5	5.0	3.7	-	3.7	0.4	4.1
1979	5.4	-	5.4	0.6	6.0	5.5	<0.1	5.5	0.6	6.1	4.2	-	4.2	0.5	4.7
1980	6.0	-	6.0	0.6	6.6	6.4	<0.1	6.4	0.7	7.1	5.1	-	5.1	0.6	5.7
1981	4.9	-	4.9	1.3	6.2	6.4	<0.1	6.4	0.5	6.9	3.2	-	3.2	0.6	3.8
1982	10.3	-	10.3	3.3	13.6	10.6	<0.1	10.6	1.6	12.2	3.1	-	3.1	0.4	3.5
1983[5]	17.5	-	17.5	2.5	20.0	11.4	<0.1	11.4	0.8	12.2	1.9	-	1.9	0.3	2.2
1984[6]	8.8	-	8.8			5.7	<0.1	5.7			1.0	-	1.0		

	Mid-Atlantic					Gulf of Maine					Grand Total				
	Nominal Catch			Estimated USA	Total	Nominal Catch			Estimated USA	Total	Nominal Catch			Estimated USA	Total
Year	USA	Foreign	Total	Discard	Catch	USA	Foreign	Total	Discard	Catch	USA	Foreign	Total	Discard	Catch
1960	-	-	-	-	-	-	-	-	-	-	14.2	-	14.2	5.2	19.4
1961	-	-	-	-	-	-	-	-	-	-	18.3	-	18.3	6.8	25.1
1962	-	-	-	-	-	-	-	-	-	-	22.9	-	22.9	8.6	31.5
1963	-	-	-	-	-	-	-	-	-	-	36.9	0.3	37.2	12.0	49.2
1964	1.8	-	1.8	<0.1	1.8	-	-	-	-	-	38.0	-	38.0	15.0	53.0
1965	2.1	-	2.1	<0.1	2.1	-	-	-	-	-	37.2	2.2	39.4	11.9	51.3
1966	2.4	-	2.4	<0.1	2.4	-	-	-	-	-	33.1	1.0	34.1	7.7	41.8
1967	5.3	-	5.3	<0.1	5.3	-	-	-	-	-	30.5	4.2	34.7	14.0	48.7
1968	3.3	-	3.3	<0.1	3.3	-	-	-	-	-	35.9	5.3	41.2	10.5	51.7
1969	3.9	0.7	4.6	<0.1	4.6	0.1	-	0.1	<0.1	0.1	36.8	20.7	57.5	5.3	62.8
1970	4.1	0.1	4.2	<0.1	4.2	0.1	-	0.1	<0.1	0.1	36.1	2.9	39.0	10.6	49.6
1971	6.9	1.0	7.9	<0.1	7.9	0.1	-	0.1	<0.1	0.1	29.2	1.8	31.0	7.1	38.1
1972	8.8	0.1	8.9	<0.1	8.9	0.2	-	0.2	<0.1	0.2	33.1	5.3	38.4	3.2	41.6
1973	4.9	0.2	5.1	0.2	5.3	0.1	-	0.1	<0.1	0.1	30.1	0.7	30.8	0.9	31.7
1974	1.9	<0.1	1.9	<0.1	1.9	0.1	-	0.1	<0.1	0.1	25.1	1.1	26.2	2.1	28.3
1975	0.7	<0.1	0.7	<0.1	0.7	0.2	-	0.2	<0.1	0.2	19.9	0.1	20.0	1.2	21.2
1976	0.3	-	0.3	<0.1	0.3	0.3	-	0.3	<0.1	0.3	17.2	<0.1	17.2	1.0	18.2
1977	0.5	<0.1	0.5	<0.1	0.5	0.2	-	0.2	<0.1	0.2	16.5	<0.1	16.5	0.2	16.7
1978	0.4	-	0.4	<0.1	0.4	0.4	-	0.4	<0.1	0.4	11.3	<0.1	11.3	1.2	12.5
1979	0.5	-	0.5	<0.1	0.5	0.3	-	0.3	<0.1	0.3	15.9	<0.1	15.9	1.7	17.6
1980	0.3	-	0.3	<0.1	0.3	0.5	-	0.5	<0.1	0.5	18.3	<0.1	18.3	1.9	20.2
1981	0.7	-	0.7	0.1	0.8	0.4	-	0.4	<0.1	0.4	15.6	<0.1	15.6	2.5	18.1
1982	0.4	-	0.4	<0.1	0.4	0.5	-	0.5	<0.1	0.5	24.9	<0.1	24.9	5.3	30.2
1983[5]	2.0	-	2.0	0.2	2.2	0.3	-	0.3	<0.1	0.3	33.1	<0.1	33.1	3.8	36.9
1984	2.4	-	2.4			0.2	-	0.2			18.1	<0.1	18.1		

[1]Statistical areas 526 and 537-539, 522-525, 514 and 521, 611+, and 511-513 and 515, respectively.

[2]Live weight equivalent of landings, excluding discard. USA data includes food and industrial landings. Food landings taken from New England weighout files, state bulletins and annual canvas data; industrial landings estimated from interview data and biological sampling of industrial catches.

[3]Discard for 1983 and prior to 1978 estimated from interview data; discard for 1978-1982 estimated from research vessel survey and gear selectivity data.

[4]Includes data for Canada, Bulgaria, Japan, Romania, Spain, and the USSR as reported to ICNAF/NAFO or as estimated by Brown and Hennemuth (1971).

[5]Provisional (incomplete).

[6]Preliminary; estimated based on USA data reported through October 1984.

Table 2. Estimated age composition (percent landed at age) plus total numbers of Southern New England and Georges Bank yellowtail in USA commercial landings, 1970-1983.

Year	Percent Landed at Age								Total Landed (000's)
	1	2	3	4	5	6	7	8+	
	Southern New England								
1970	-	10.6	28.3	43.3	14.2	3.2	0.3	0.1	30230
1971	-	13.6	19.3	42.0	19.4	4.4	1.1	0.1	18743
1972	-	15.2	30.2	14.3	31.0	7.0	1.7	0.6	19364
1973	0.1	15.7	41.2	25.2	9.1	7.0	1.3	0.4	18068
1974	2.1	12.7	24.5	31.8	15.4	5.7	6.4	1.4	15148
1975	2.1	34.6	19.3	11.8	17.9	7.4	4.6	2.3	8071
1976	-	39.2	24.1	7.4	10.1	11.3	4.9	2.9	3572
1977	0.3	28.4	55.4	6.4	2.3	3.3	1.6	2.3	6917
1978	0.2	57.8	22.3	15.3	2.5	0.8	0.5	0.7	6030
1979	0.2	39.1	50.9	6.5	2.5	0.7	0.1	-	13177
1980	0.7	32.2	40.8	22.6	2.7	0.7	0.1	0.1	15365
1981	-	22.0	47.4	21.5	7.8	1.3	-	-	10332
1982	0.2	56.8	34.6	6.8	1.2	0.3	0.1	-	30916
1983	0.1	28.4	65.9	5.0	0.5	0.2	-	-	51016
	Georges Bank								
1970	0.1	15.0	40.4	27.7	11.1	3.7	1.2	0.9	29179
1971	-	9.0	40.2	32.2	11.9	4.5	1.4	0.9	21811
1972	-	12.2	39.2	30.7	13.6	3.3	0.7	0.3	28082
1973	-	10.5	41.7	30.0	12.1	4.3	0.9	0.4	30720
1974	1.1	27.9	30.4	25.0	11.0	2.5	1.4	0.5	28500
1975	0.9	52.9	23.4	10.9	7.2	2.7	1.2	0.8	29170
1976	0.1	67.2	21.8	5.4	2.1	1.7	1.1	0.6	25733
1977	0.2	36.7	49.5	8.9	2.0	1.2	0.8	0.7	18628
1978	-	26.4	44.7	21.3	5.1	1.5	0.4	0.6	7325
1979	0.2	52.7	27.5	11.2	5.8	1.2	0.9	0.5	11733
1980	-	14.6	70.5	11.2	2.7	0.8	0.1	0.1	12260
1981	-	2.9	47.5	42.2	6.1	1.2	-	-	10039
1982	0.8	50.0	31.2	13.2	4.2	0.5	0.1	-	26350
1983	0.9	27.5	60.1	8.7	2.3	0.4	0.1	-	26925

Table 3. Commercial catch (000's tons), days fished (000's) and catch per day (tons)[1] of yellowtail flounder for the Southern New England, Georges Bank, and Cape Cod grounds.

	Southern New England			Georges Bank			Cape Cod		
Year	Total Catch	Days Fished	Catch/ Day	Total Catch	Days fished	Catch/ Day	Total Catch	Days fished	Catch/ Day
1960	11.5	4.60	2.5	5.9	2.02	2.9	2.0	1.12	1.8
1961	17.0	4.85	3.5	5.7	1.82	3.1	2.4	0.91	2.6
1962	18.6	4.04	4.6	10.4	2.35	4.4	2.5	1.01	2.5
1963	27.9	5.47	5.1	16.7	3.63	4.6	4.6	1.00	4.6
1964	29.0	5.08	5.6	19.8	3.53	5.6	2.4	0.71	3.4
1965	27.8	6.61	4.2	19.4	4.68	4.2	2.0	0.70	2.8
1966	23.6	8.42	2.8	13.7	5.71	2.4	2.1	1.37	1.6
1967	25.8	6.51	4.0	15.3	4.13	3.7	2.3	1.69	1.4
1968	28.0	6.66	4.2	18.2	4.66	3.9	2.2	0.99	2.3
1969	35.6	10.78	3.3	20.9	6.71	3.1	1.6	0.68	2.5
1970	22.4	6.40	3.5	21.3	6.26	3.4	1.6	0.53	3.0
1971	12.2	3.81	3.2	15.5	6.20	2.5	2.4	0.79	3.0
1972	13.2	4.71	2.8	17.6	8.00	2.2	1.7	0.67	2.5
1973	7.8	4.11	1.9	16.8	6.96	2.4	1.7	0.89	1.9
1974	7.2	3.74	1.9	16.8	8.40	2.0	2.3	1.21	1.9
1975	3.4	2.43	1.4	14.9	8.59	1.7	2.0	1.25	1.6
1976	1.8	1.50	1.2	12.1	7.50	1.6	3.7	2.31	1.6
1977	2.8	2.00	1.4	9.7	6.70	1.4	3.5	2.42	1.4
1978	2.6	1.44	1.8	5.0	3.57	1.4	4.1	2.05	2.0
1979	6.0	3.00	2.0	6.1	3.05	2.0	4.7	2.61	1.8
1980	6.6	3.17	2.1	7.1	4.26	1.7	5.7	3.25	1.8
1981	6.2	2.59	2.4	6.9	4.16	1.6	3.8	2.30	1.9
1982	13.6	3.78	3.6	12.2	5.62	2.2	3.5	2.02	1.8
1983	20.0	6.71	3.0	12.2	5.53	2.2	2.2	1.25	1.8

[1]Calculated for USA trawlers of 5-104 GT using trip data for which 50% of the total catch consisted of yellowtail.

Table 4. Stratified mean catch per tow in numbers and weight (kg) for Southern New England yellowtail flounder in NEFC offshore[1] spring and autumn bottom trawl surveys, 1963-1984.

Year	Age 0	1	2	3	4	5	6	7	8+	Total No.	Total Wt. (kg)
	Spring[2]										
1968	0.00	2.80	45.36	46.22	27.17	1.44	0.16	0.09	0.00	123.24	32.21
1969	0.00	7.44	28.12	39.55	21.42	3.84	0.25	0.00	0.00	100.62	23.10
1970	0.00	2.15	15.24	28.93	20.38	5.98	1.55	0.33	0.14	74.70	20.28
1971[3]	-	-	-	-	-	-	-	-	-	74.48	18.49
1972	0.00	0.84	31.38	21.26	6.64	12.69	1.92	0.44	0.00	75.17	18.55
1973	0.00	1.90	10.47	18.34	9.06	6.15	9.53	1.18	0.66	57.29	14.69
1974	0.00	1.07	4.28	3.36	3.60	2.35	0.85	1.44	0.32	17.27	5.04
1975	0.00	0.82	2.25	0.72	1.00	1.28	0.68	0.05	0.21	7.01	1.98
1976	0.00	0.04	4.70	0.75	0.38	0.43	0.38	0.19	0.09	6.96	2.45
1977	0.00	0.35	1.76	2.24	0.22	0.26	0.12	0.04	0.16	5.15	1.99
1978	0.00	4.43	14.04	2.85	1.03	0.27	0.05	0.07	0.20	22.94	5.15
1979	0.00	2.22	4.84	2.57	0.45	0.16	0.00	0.00	0.01	10.25	2.15
1980	0.00	0.54	6.21	4.73	3.90	0.42	0.15	0.02	0.04	16.01	5.95
1981	0.00	0.35	14.55	5.24	2.16	0.78	0.11	0.00	0.07	23.26	6.85
1982	0.00	1.09	22.58	13.53	3.12	0.99	0.28	0.04	0.00	41.63	10.38
1983	0.00	0.12	6.05	18.59	1.28	0.32	0.00	0.00	0.00	26.36	8.03
1984	0.00	0.00	1.36	3.73	2.20	0.51	0.23	0.00	0.00	8.03	2.85
	Autumn										
1963	0.05	16.46	15.23	13.98	4.26	0.55	0.00	0.08	0.00	50.61	16.83
1964	0.00	18.47	26.19	4.80	7.13	3.27	0.80	0.11	0.00	60.77	19.03
1965	0.26	11.63	16.90	6.20	1.77	1.73	0.21	0.04	0.00	38.74	12.68
1966	0.88	35.92	10.44	1.78	1.02	0.19	0.00	0.00	0.00	50.23	9.43
1967	0.27	18.44	25.65	11.14	1.57	0.40	0.06	0.13	0.00	57.66	14.05
1968	0.00	10.72	9.47	18.08	1.12	0.00	0.61	0.19	0.04	40.23	10.06
1969	0.00	11.88	9.74	27.48	5.47	0.12	0.04	0.04	0.00	54.77	14.39
1970	0.04	4.23	5.52	16.34	10.62	2.51	0.43	0.07	0.00	39.76	10.96
1971	0.00	6.34	10.84	6.25	15.20	2.69	0.22	0.16	0.00	41.70	9.18
1972[3]	-	-	-	-	-	-	-	-	-	73.28	20.11
1973	0.00	1.56	1.19	1.80	1.34	1.00	0.83	0.23	0.00	7.95	2.25
1974	0.21	1.02	1.64	0.59	2.25	0.96	0.40	0.19	0.07	7.33	2.13
1975	0.00	1.67	0.50	0.19	0.23	0.22	0.00	0.09	0.00	2.90	0.71
1976	0.00	2.99	6.18	0.54	0.07	0.11	0.30	0.35	0.15	10.69	2.96
1977	0.04	1.70	2.19	0.80	0.12	0.04	0.04	0.08	0.00	5.01	1.50
1978	0.00	3.26	7.20	0.43	0.38	0.04	0.01	0.08	0.03	11.43	3.06
1979	0.00	1.73	4.42	2.40	0.37	0.04	0.04	0.00	0.00	9.00	2.57
1980	0.00	1.48	4.33	1.18	0.34	0.00	0.00	0.00	0.00	7.33	1.96
1981	0.00	3.24	9.25	1.06	1.21	0.02	0.04	0.00	0.00	14.82	3.79
1982	0.00	2.14	24.17	7.02	0.84	0.33	0.00	0.00	0.00	34.50	8.13
1983	0.00	2.61	15.93	8.17	0.70	0.08	0.00	0.04	0.00	27.53	6.51
1984[3]	0.00	0.67	-	-	-	-	-	-	-	4.51	1.37

[1]Offshore strata 5, 6, 9, and 10.

[2]Data for 1968-1972 and 1982-1984 adjusted by factors of 1.76 (numbers) and 1.73 (weight) to account for differences in fishing power between the "36 Yankee" and the "41 Yankee" trawls (Sissenwine and Bowman 1978).

[3]Age data not available; age 1 catch estimated from survey catch per tow at length.

Table 5. Stratified mean catch per tow in numbers and weight (kg) for Georges Bank yellowtail flounder in NEFC offshore[1] spring and autumn bottom trawl surveys, 1963-1984.

Year	Age 0	1	2	3	4	5	6	7	8+	Total No.	Total wt (kg)
Spring[2]											
1968	0.00	0.26	4.79	5.16	0.44	0.11	0.26	0.18	0.00	11.20	3.77
1969	0.00	1.55	13.46	16.05	4.47	2.06	0.65	0.12	0.25	38.61	15.10
1970	0.00	0.12	6.46	8.55	3.66	0.83	0.18	0.18	0.09	20.07	7.16
1971[3]	-	-	-	-	-	-	-	-	-	19.57	6.23
1972	0.00	0.19	10.31	10.40	5.09	1.43	0.05	0.16	0.14	27.77	8.72
1973	0.00	2.80	4.73	3.43	1.54	0.59	0.25	0.03	0.03	13.40	3.97
1974	0.00	0.46	3.22	2.67	1.80	0.52	0.27	0.10	0.03	9.07	3.67
1975	0.00	0.61	4.61	1.01	0.41	0.25	0.07	0.00	0.02	6.98	2.26
1976	0.00	1.58	6.26	1.81	0.45	0.28	0.04	0.07	0.06	10.55	3.07
1977	0.00	0.00	0.98	1.62	0.57	0.09	0.02	0.00	0.00	3.28	1.35
1978	0.00	1.36	1.16	0.73	0.30	0.06	0.00	0.01	0.00	3.62	1.00
1979	0.00	0.40	2.81	0.54	0.47	0.08	0.07	0.05	0.01	4.43	1.66
1980	0.00	0.08	6.69	8.39	0.68	0.08	0.05	0.00	0.00	15.99	6.02
1981	0.00	1.71	3.07	1.09	0.36	0.13	0.03	0.00	0.01	6.40	3.12
1982	0.00	0.09	7.59	2.50	0.70	0.16	0.00	0.00	0.05	11.09	3.98
1983	0.00	0.00	2.68	4.00	0.86	0.26	0.09	0.00	0.05	7.94	3.57
1984	0.00	0.00	0.95	1.25	1.23	0.65	0.05	0.00	0.00	4.13	2.21
Autumn											
1963	0.00	12.39	6.28	9.53	1.21	0.41	0.08	0.14	0.09	30.13	9.99
1964	0.00	1.42	7.97	6.04	4.92	2.21	0.31	0.08	0.02	22.97	10.64
1965	0.02	0.96	4.79	4.82	2.89	1.29	0.09	0.17	0.02	15.05	7.10
1966	1.17	9.93	1.46	1.40	0.67	0.10	0.04	0.00	0.00	14.77	3.12
1967	0.05	7.49	7.63	2.21	0.83	0.25	0.06	0.05	0.00	18.57	5.92
1968	0.00	9.67	9.72	4.76	0.64	0.78	0.03	0.00	0.00	25.60	8.22
1969	1.05	6.67	8.52	4.79	1.36	0.36	0.22	0.15	0.00	23.12	7.25
1970	0.78	3.77	4.21	2.58	1.60	0.37	0.05	0.01	0.00	13.37	3.88
1971	0.03	2.97	5.64	4.08	1.84	0.45	0.19	0.02	0.02	15.24	4.97
1972[3]	-	-	-	-	-	-	-	-	-	14.56	4.93
1973	0.10	2.04	4.51	4.18	2.41	1.00	0.34	0.14	0.02	14.74	5.07
1974	1.01	3.79	2.35	1.24	0.87	0.38	0.20	0.11	0.00	9.95	2.86
1975	0.36	3.79	2.06	0.72	0.47	0.27	0.03	0.00	0.03	7.73	1.81
1976	0.00	0.27	1.58	0.39	0.10	0.10	0.03	0.00	0.06	2.53	1.18
1977	0.00	0.91	2.13	1.56	0.01	0.10	0.06	0.04	0.02	4.83	2.56
1978	0.04	4.59	1.24	0.75	0.39	0.13	0.01	0.00	0.02	7.17	2.15
1979	0.02	1.27	2.00	0.25	0.13	0.13	0.03	0.06	0.02	3.91	1.37
1980	0.08	0.66	5.27	5.57	0.67	0.27	0.16	0.03	0.03	12.74	6.07
1981	0.00	1.67	2.26	1.28	0.61	0.07	0.05	0.00	0.08	6.02	2.37
1982	0.00	1.99	1.82	1.27	0.35	0.07	0.00	0.00	0.00	5.50	1.77
1983	0.00	0.07	1.83	1.45	0.37	0.02	0.01	0.00	0.03	3.78	1.56
1984[3]	0.00	0.29	-	-	-	-	-	-	-	1.29	0.38

[1]Offshore strata 13-21.

[2]Date for 1968-1972 and 1982-1984 adjusted by factors of 1.76 (numbers) and 1.73 (weight) to account for differences in fishing power between the "36 Yankee" and the "41 Yankee" trawls (Sissenwine and Bowman 1978).

[3]Age data not available; age 1 catch estimated from survey catch per tow at length.

Table 6. Stratified mean catch per tow in numbers and weight (kg) for Cape Cod yellowtail flounder in NEFC offshore[1] spring and autumn bottom trawl surveys, 1963-1984.

	Spring[2]		Autumn	
Year	Nos.	Wt(kg)	Nos.	Wt(kg)
1963	-	-	9.07	3.54
1964	-	-	3.67	1.18
1965	-	-	4.50	1.23
1966	-	-	4.02	0.80
1967	-	-	0.74	0.27
1968	0.40	0.00	0.88	0.29
1969	0.77	0.43	2.37	0.85
1970	4.00	1.16	1.16	0.31
1971	2.76	0.47	1.49	0.35
1972	1.78	0.28	10.24	2.75
1973	1.63	0.31	1.60	0.58
1974	1.81	0.71	0.22	0.12
1975	2.62	0.31	0.93	0.39
1976	3.31	0.84	4.81	1.21
1977	1.08	0.40	12.93	4.66
1978	0.22	0.08	4.51	1.37
1979	0.47	0.11	3.87	1.01
1980	2.25	0.63	12.60	3.47
1981	1.63	0.28	2.94	0.76
1982	6.31	3.27	3.80	1.36
1983	3.40	1.88	0.15	0.05
1984	1.18	0.36	2.24	1.03

[1]Offshore strata 24-26.

[2]Data for 1968-1972 and 1982-1984 adjusted by factors of 1.76 (numbers) and 1.73 (weight) to account for differences in fishing power between the "36 Yankee" and the "41 Yankee" trawls (Sissenwine and Bowman 1978).

Table 7. Stratified mean catch per tow in numbers and weight (kg) for yellowtail flounder in Massachusetts inshore spring and autumn bottom trawl surveys[1] from Cape Cod to Massachusetts Bay, 1978-1984.

Season/ year	Stratified mean catch per tow at age[1] (numbers)									Total	Stratified mean catch/tow in weight(kg)
	0	1	2	3	4	5	6	7	8+		
Spring											
1978	0.00	2.71	20.69	11.82	1.60	0.63	0.54	0.10	0.13	38.22	10.16
1979	0.00	2.63	22.58	13.85	3.68	0.86	0.00	0.17	0.00	43.77	11.38
1980	0.00	2.68	17.62	10.10	2.30	0.15	0.00	0.00	0.00	32.85	10.03
1981	0.02	5.61	58.83	9.00	2.26	1.59	0.27	0.00	0.00	77.58	16.35
1982	0.00	0.69	17.06	17.04	4.45	0.94	0.06	0.04	0.00	40.27	12.66
1983	0.00	3.13	8.50	11.51	4.28	0.04	0.17	0.03	0.00	27.66	9.36
1984										29.15	7.38
Autumn											
1978	0.04	7.13	7.74	1.45	0.11	0.00	0.01	0.00	0.00	16.48	2.80
1979	0.03	24.11	22.82	1.78	0.06	0.00	0.00	0.00	0.00	48.80	7.33
1980	0.03	26.54	12.38	2.70	0.35	0.00	0.00	0.00	0.00	42.00	5.90
1981	0.00	2.93	6.54	1.54	0.23	0.17	0.00	0.00	0.00	11.41	2.83
1982	0.00	9.58	6.36	5.54	0.30	0.08	0.00	0.00	0.00	21.87	4.10
1983	0.00	9.68	6.68	1.60	0.13	0.00	0.00	0.00	0.00	18.09	2.92
1984										6.33	1.18

[1]Regions 3, 4, and 5 (strata 17-21, 25-30, and 31-36).

Table 8. Stratified mean catch per tow in numbers and weight (kg) for Mid-Atlantic yellowtail flounder in NEFC offshore[1] spring and autumn bottom trawl surveys, 1963-1984.

	Spring[2]		Autumn	
Year	Nos.	Wt (kg)	Nos.	Wt (kg)
1963	-	-	28.83	8.93
1964	-	-	16.40	4.85
1965	-	-	49.05	5.82
1966	-	-	48.27	8.85
1967	-	-	55.58	9.31
1968	153.00	29.44	81.32	13.47
1969	120.74	23.87	45.35	9.92
1970	83.76	19.46	45.21	10.31
1971	64.24	13.63	26.97	3.77
1972	67.39	17.14	86.24	20.95
1973	32.10	9.19	8.24	1.87
1974	13.38	4.38	0.66	0.19
1975	2.01	0.80	0.87	0.15
1976	4.28	0.95	0.38	0.06
1977	7.30	1.77	1.43	0.18
1978	9.93	2.02	1.19	0.22
1979	2.41	0.60	1.04	0.20
1980	11.91	3.59	0.80	0.15
1981	27.97	6.37	18.69	2.38
1982	42.17	9.07	10.60	1.76
1983	23.89	5.78	1.71	0.33
1984	6.18	1.73	1.68	0.18

[1]Offshore strata 69, 70, 73-74, 1, and 2.

[2]Data for 1968-1972 and 1982-1984 adjusted by factors of 1.76 (numbers) and 1.73 (weight) to account for differences in fishing power between the "36 Yankee" and the "41 Yankee" trawls (Sissenwine and Bowman 1978).

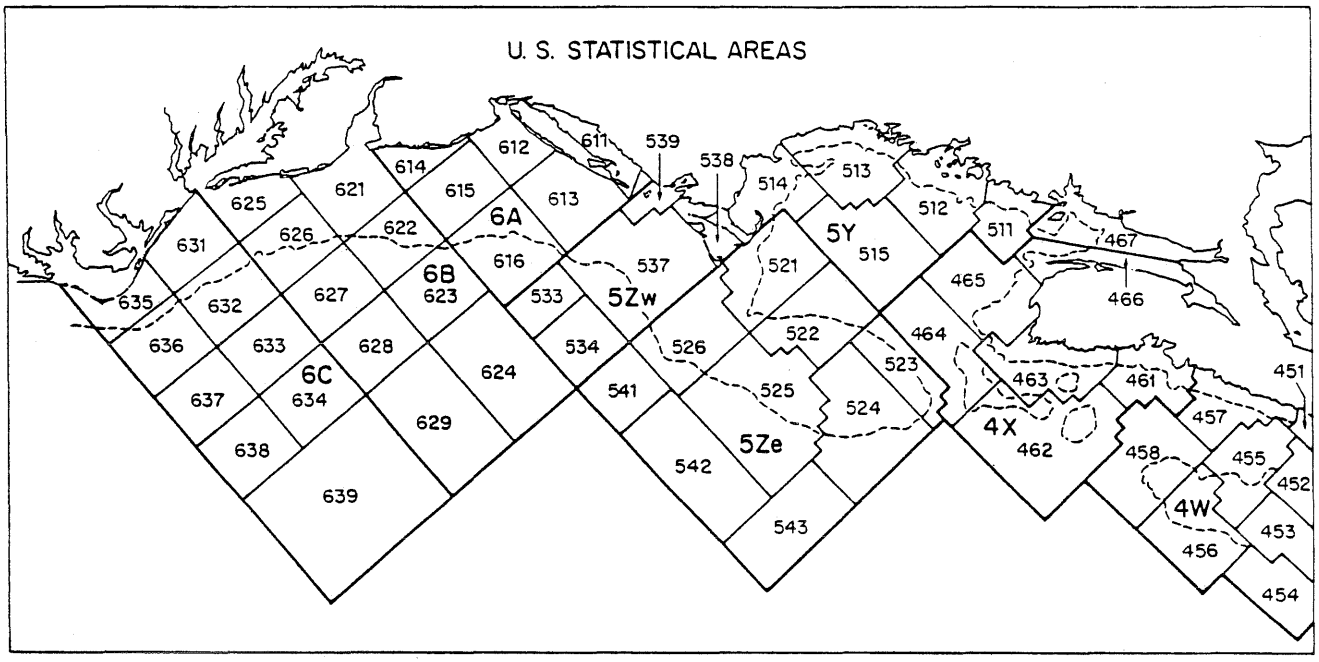

Figure 1. U.S. statistical areas used for commercial reporting purposes. Yellowtail fishing grounds defined by statistical area are as follows: Southern New England, 526 and 537-539; Georges Bank, 522-525; Cape Cod, 514 and 521; Mid-Atlantic, 611+; and Gulf of Maine, 511-513 and 515.

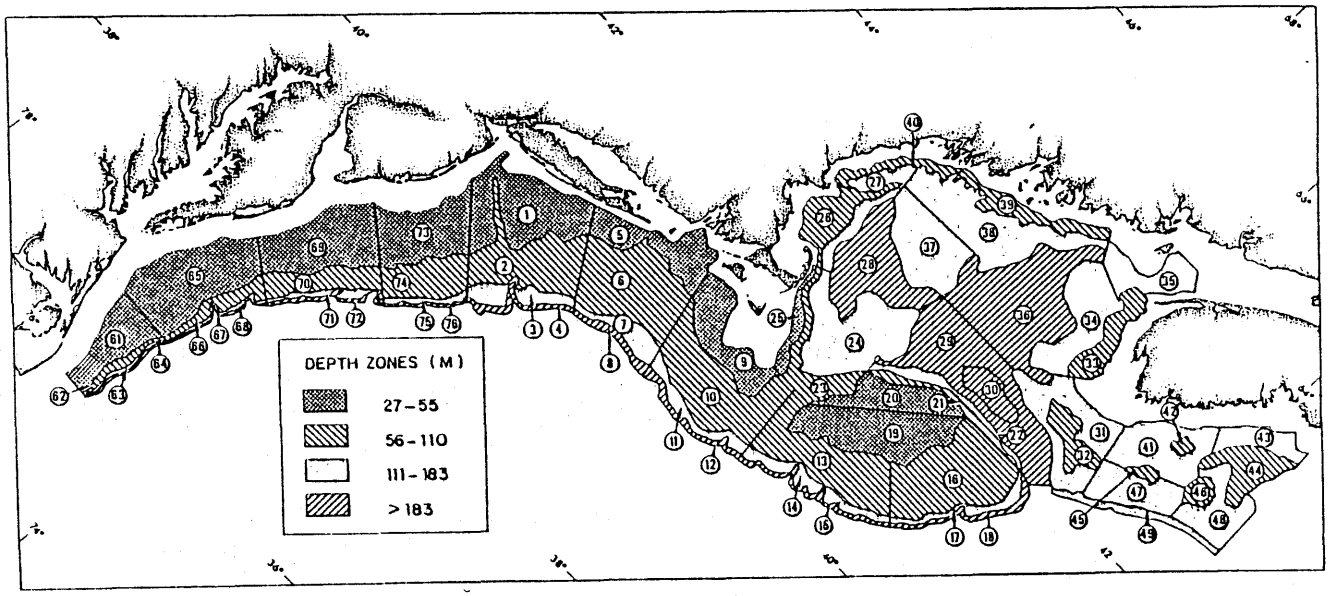

Figure 2. Strata used in NEFC offshore (>27 m) spring and autumn bottom trawl surveys. In this assessment yellowtail grounds are defined by strata set as follows: Southern New England, strata 5, 6, 9, and 10; Georges Bank, strata 13-21; Cape Cod, strata 24-26; and Mid-Atlantic, strata 69, 70, 73, 74, 1, and 2.

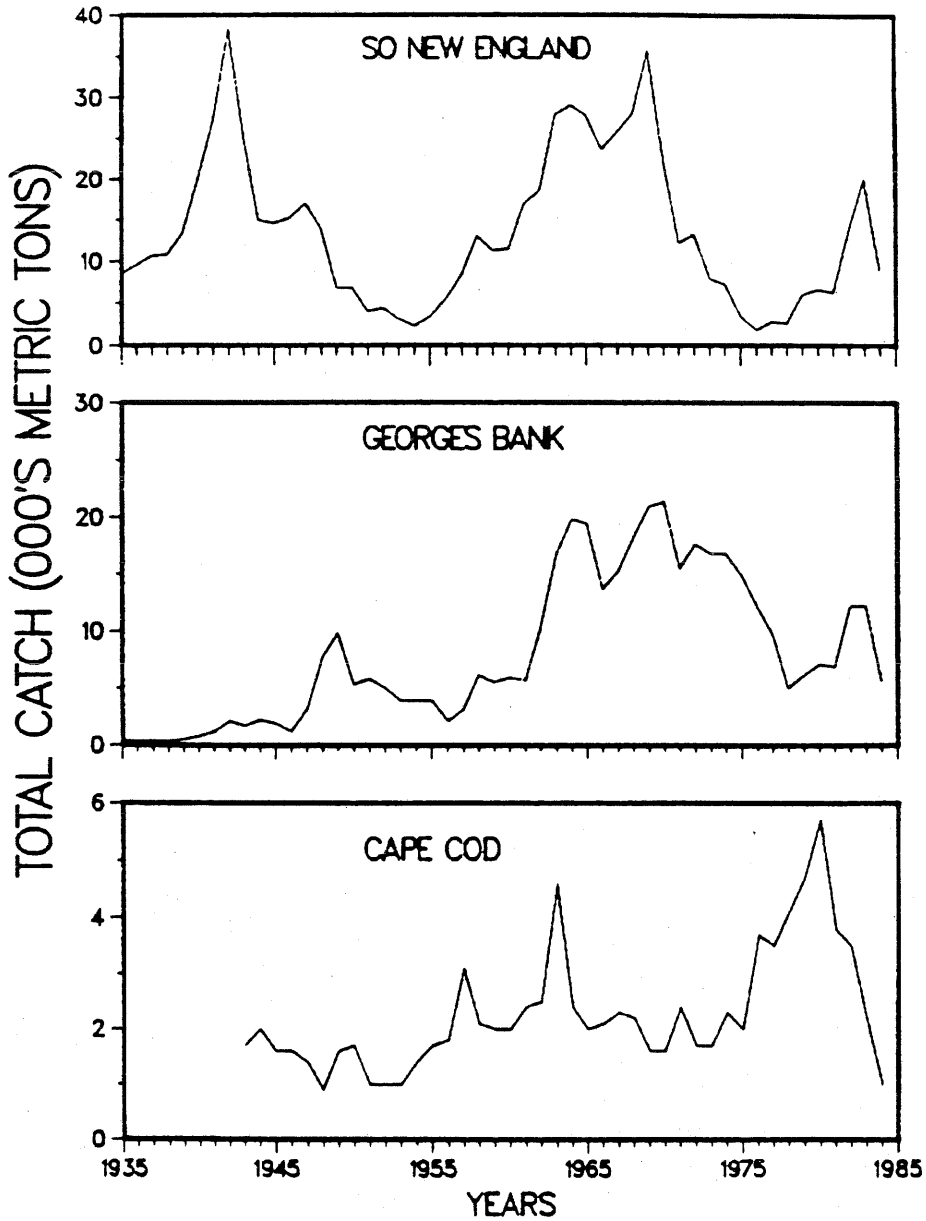

Figure 3. Total commercial catch of Southern New England, Georges Bank, and Cape Cod yellowtail flounder, 1935-1984.

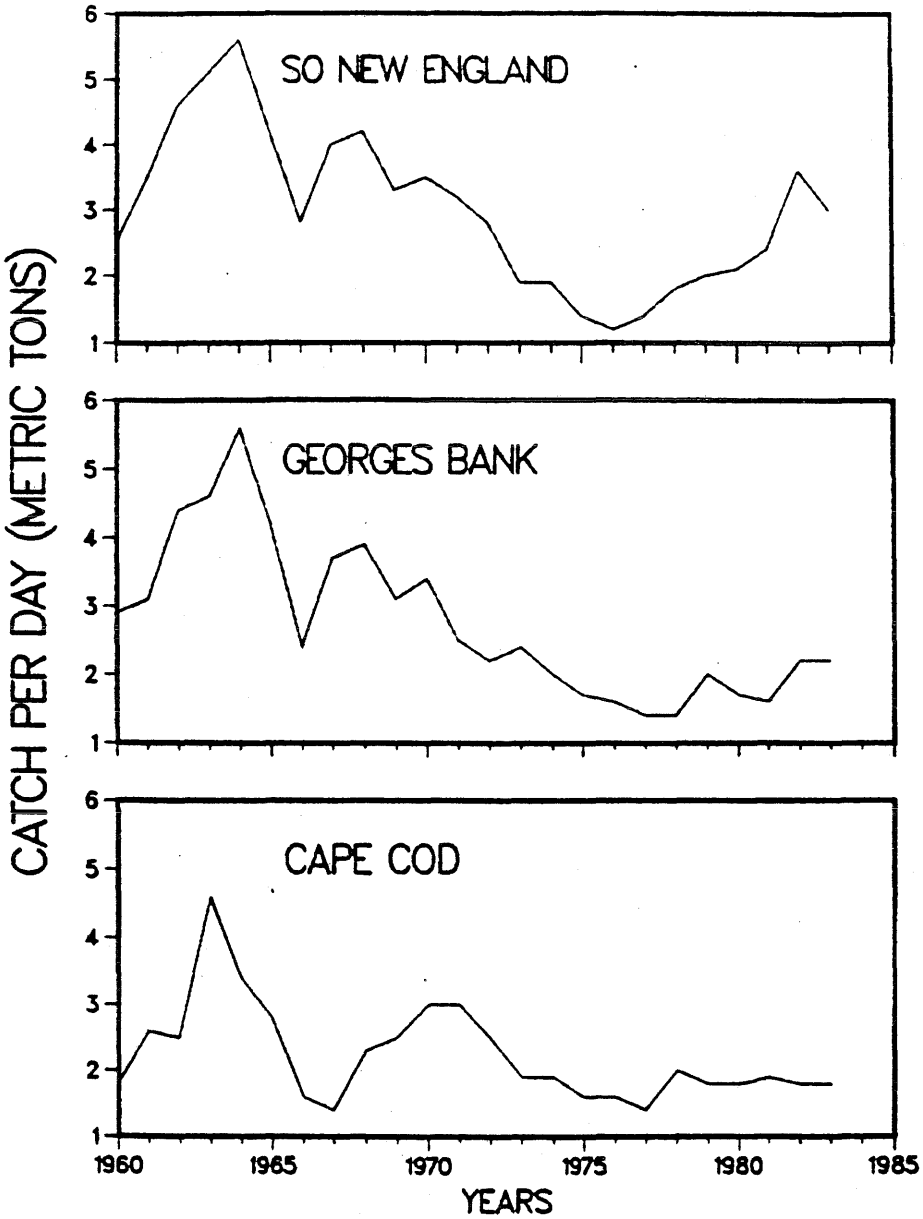

Figure 4. Commercial abundance indices (metric tons per standard day fished) for Southern New England, Georges Bank, and Cape Cod yellowtail flounder, 1960-1983.

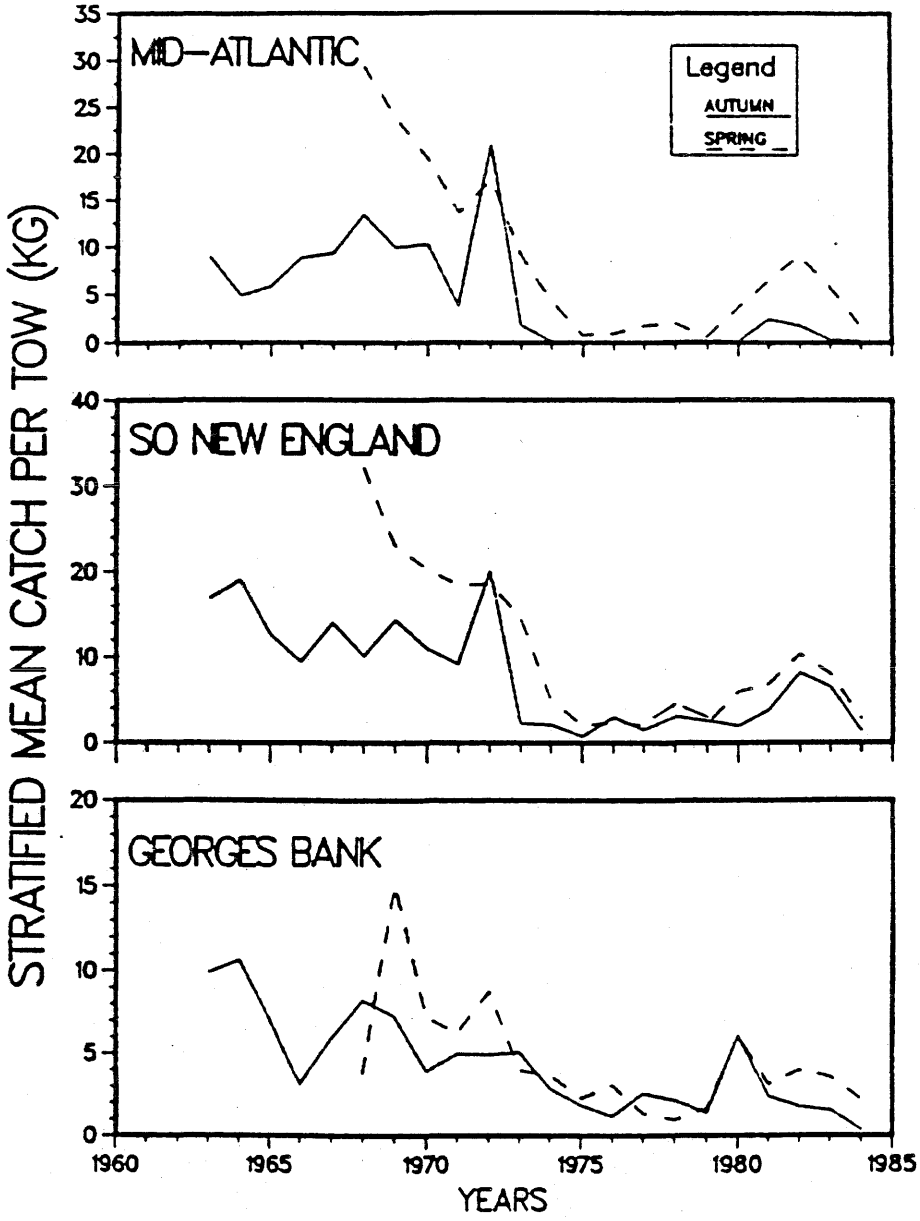

Figure 5. Stratified mean catch per tow (kg) of Mid-Atlantic, Southern New England, and Georges Bank yellowtail flounder from NEFC offshore spring and autumn surveys, 1963-1984.

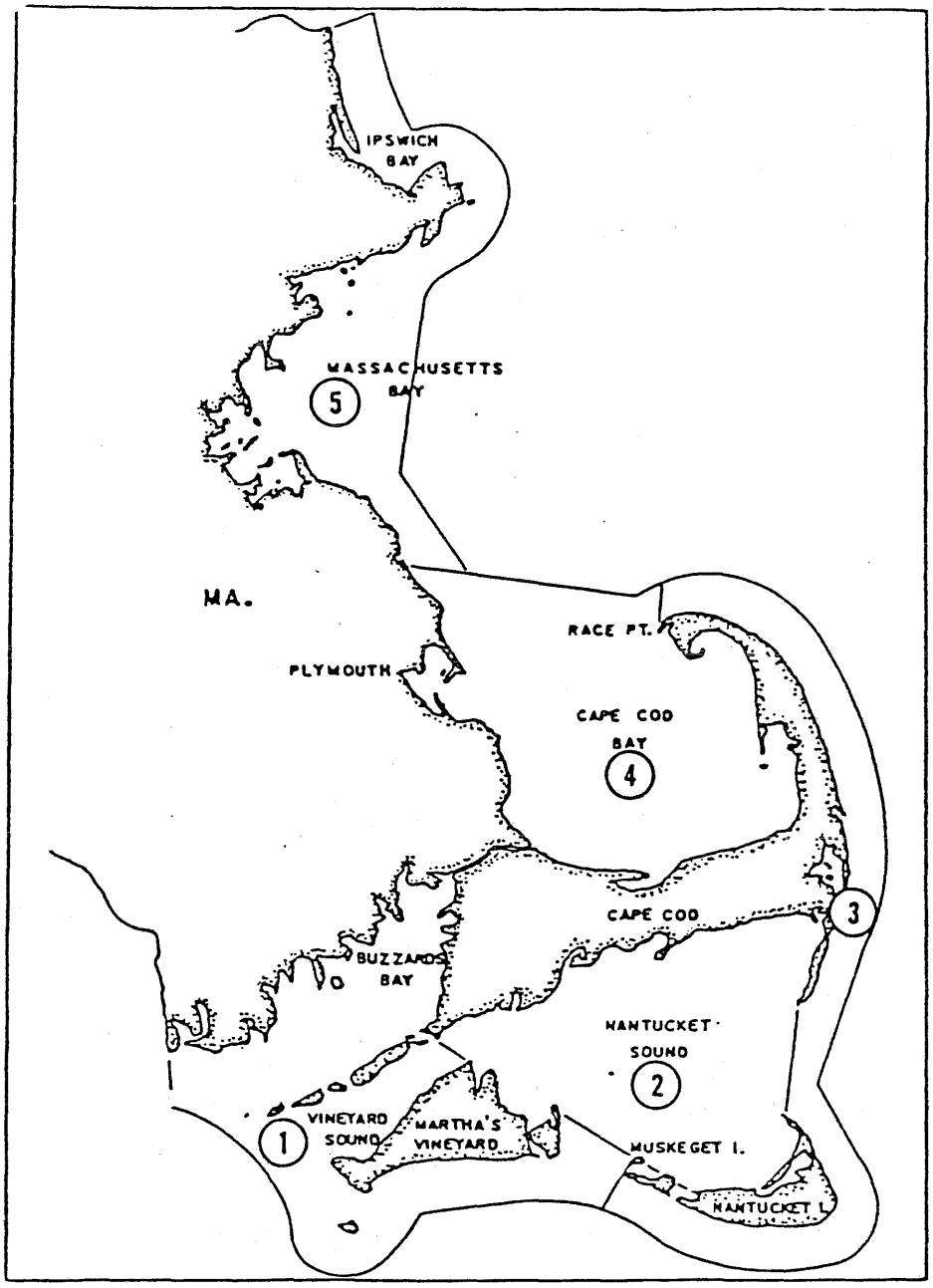

Figure 6. Massachusetts inshore bottom trawl survey area delineated by regions.

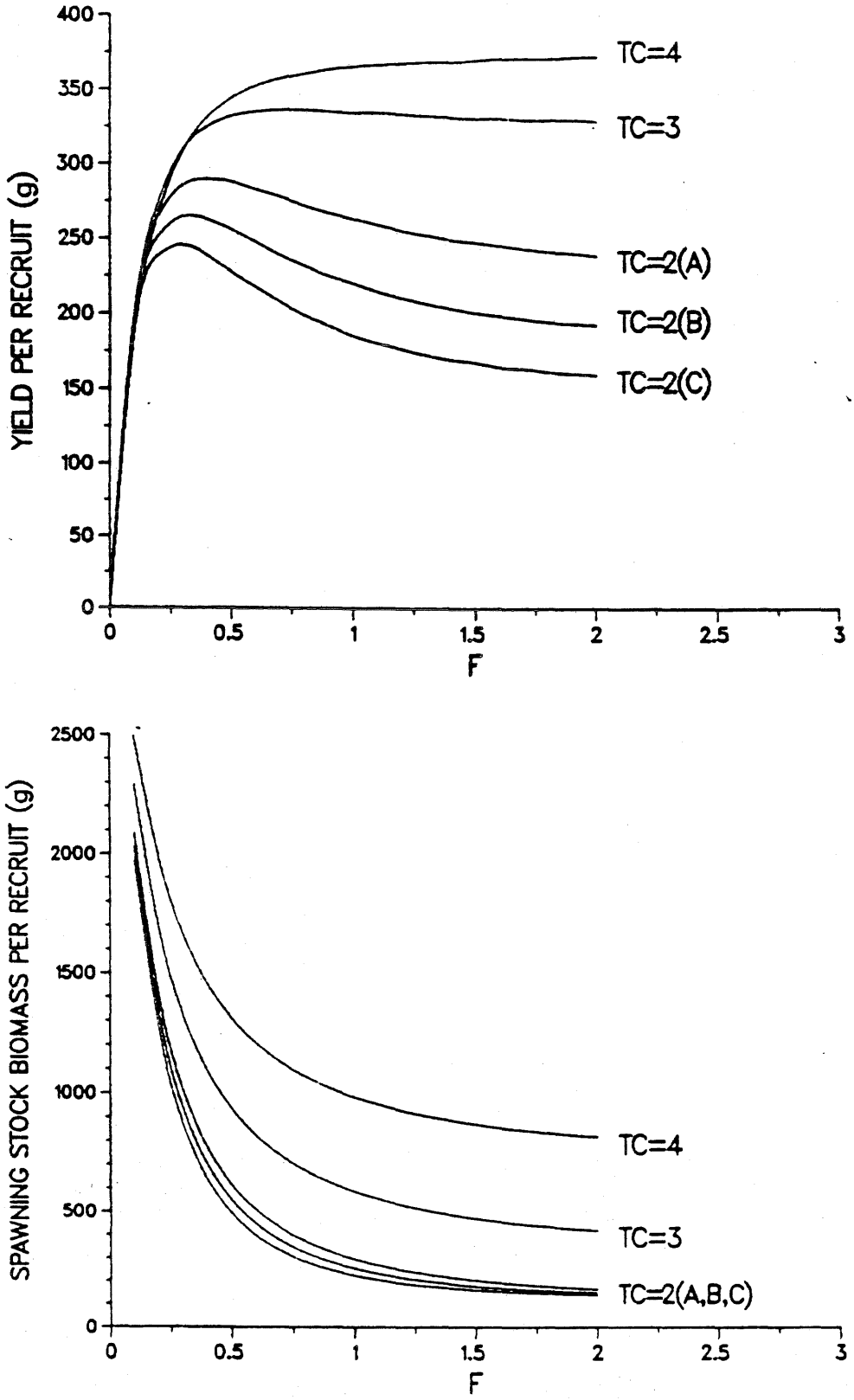

Figure 7. Yield and spawning stock biomass per recruit (g) for mean ages at recruitment (t_c) of 2, 3, and 4 years for Southern New England yellowtail flounder plotted against instantaneous fishing mortality (F). Options 2(A), 2(B), and 2(C) incorporate discard factors of zero and zero, 0.25, and 0.05, and 0.50 and 0.10 of the landings by number of age 2 and 3 fish, respectively.