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Summary and Review of the 1978 Assessment and Status
of the
Georges Bank and Gulf of Maine Cod Stocks

by

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Tables and Figures

- Table 1. Cod - Life History Summary
- Figure 2. Cod Stock Areas (Wise, J.P., 1962)
- Figure 3. Commercial Landings of Atlantic Cod
From Georges Bank (ICNAF Div 5Z)
- Figure 4. USA Commercial Landings of Haddock and Cod
From Georges Bank (ICNAF Div 5Z)
- Figure 5. Commercial Landings of Atlantic Cod
From the Gulf of Maine (ICNAF Div 5Y)
- Figure 6. Georges Bank Cod - Survey Data
- Figure 7. Georges Bank Cod Commercial USA Catch, Quarter 3
- Figure 8. Atlantic Cod Landings - Georges Bank by Market
Category, 1971-1977
- Figure 9. Atlantic Cod Stock Size on Georges Bank
- Figure 10. USA Commercial Catch Per Day of Atlantic Cod
From Georges Bank
- Figure 11. Gulf of Maine Cod - Survey Data
- Figure 12. Atlantic Cod Landings - Gulf of Maine by Market
Category, 1971-1977
- Table 2. Projected Atlantic Cod Catch in 1978 from the
Georges Bank Stock ...

Summary of Atlantic Cod Assessment for Public Hearing on
Groundfish Fishery Management Plan

I. Background Life History Information

Brief summary of distribution, habitats, reproduction, growth, food, and migration (Summary Table 1 - outlines all of these data).

II. Fishing Areas

Four groups of cod in U.S. Atlantic waters: Gulf of Maine, Georges Bank, Southern New England, and New Jersey coast (Figure 2). Tagging studies and growth rate analyses suggests intermingling between Gulf of Maine and other groups is minimal; exchanges between the three southerly groups are more extensive, particularly between the Southern New England and New Jersey populations. Presently, the cod groups are managed as two "units" or "stocks": (1) Gulf of Maine (ICNAF Div 5Y) and (2) Georges Bank and southward (ICNAF Div. 5Z and SA 6).

Recreational fishing (primarily party-boat activity) is important in both stocks. The Gulf of Maine recreational fishery occurs primarily during the summer in the lower Gulf of Maine; the Georges Bank fishery transpires primarily in the late fall and winter in inshore waters south of Cape Cod, particularly off of Long Island and New Jersey.

III. Review of catch history of each "stock" (Figures 3-5)

Georges Bank commercial landings - fishery has existed since 17th century. Landings data available since 1893. Recent history (since 1932): catch stable from 30's to late 40's (Figure 3), declined to lowest level in 1953, rapidly increased during the 1960's due to foreign exploitation, reaching near-record levels in 1966 (Soviet Union and Canadian effort) and 1968 (Spanish effort) and has steadily declined until 1976. The US commercial harvest has remained relatively stable from 1961-1976. The average long-term (1932-75) commercial catch of Georges Bank cod is about 22,000 tons (all countries); 16,000 tons (US only).

Prior to mid 1960's and the decline of the haddock stock on Georges Bank, cod were generally taken as a by-catch in the haddock fishery (Figure 4). Since 1967, however, cod has become more of a primary species (directed catch) in the groundfish fishery.

Gulf of Maine commercial landings - Since 1931, landings have fluctuated between 2,700 tons (1957) and 14,500 tons (1945) (Figure 5). Catch declined steadily from 1945 to the late 50's and early 60's. From 1963-69, catch increased annually, but declined sequentially afterward until 1973. Since 1973, annual landings have increased by almost 1,000 tons a year.

Foreign (mainly Canada) catches from the Gulf of Maine have been relatively insignificant; only an average of 165 tons were taken annually 1960-76.

The long-term (1932-75) commercial catch of Gulf of Maine cod is about 6,200 tons; during 1966-75 commercial removals averaged about 7,100 tons annually.

Recreational landings - available from four marine angling surveys done in 60, 65, 70 and 74.

Georges Bank - prorated recreational catches (from total Maine - New Jersey) varied between 10,000 - 13,250 tons from the four surveys. The mean of the four survey estimates was 11,400 tons.

Gulf of Maine - prorated recreational catches varied between 2,300 - 3,000 tons in the surveys. The mean value from the survey estimates was 2,600 tons.

IV. Condition of the Stocks

Data on the condition of both cod stocks are available from both commercial and research survey sources:

Georges Bank - Both bottom trawl survey and commercial length-frequency data (Figures 6-7) indicate that two strong year-classes have appeared in the fishery since 1970 (71 and 75 year-classes). These first appear in the bottom trawl surveys as young-of-the-year fish (<20 cm; <8 inches) and are later seen in the commercial catch as 2 year old fish (40-60 cm fish; 16-24 inches). The distribution of commercial landings by market category (Figure 8) further corroborates the presence of these strong year-classes in the fishery (note the similarity in Figures 6-8 between 1973 and 1977).

The age composition of the 1977 commercial landings indicate that ages 2 + 3 fish comprised 85% of the catch (in numbers). The unimodal nature of the 1977 commercial length-frequency distribution reflects this reliance on scrod cod in the commercial fishery (Figure 7 again).

The 1977 research survey abundance indices indicate two events within the Georges Bank population: (1) the catch per tow (abundance) of fish age 2 and older (in numbers) and the total weight per tow were among the highest in the survey time-series (although the weight per tow did decline slightly from the 1976 value) and (2) the abundance indices of juvenile fish (ages 0 and 1) were the lowest ever seen in the history of the autumn survey. (Note the virtual absence of fish <20 cm (8") in the survey length-frequencies for 1976 and 1977 - Figure 6 again.) These data, in conjunction with the commercial data, indicate that the Georges Bank cod stock size is higher than it has been in recent years (since 1971), but is composed primarily of only young maturing fish (ages 3 and 4 in 1978). These results also indicate that these fish

(year-classes) will remain the principal harvestable portion of the population during 1978 and 1979 (as they were in 1977) since recruitment was poor in 1976 and 1977, compared with earlier years.

An analysis using commercial and recreational landings-at-age data (virtual population analysis) substantiates the above population conditions and also depicts the current improvement in stock size from those evident in recent years (Figure 9). The current stock level, however, is still well below the stock size of the middle 1960's.

The use of commercial catch per day data (Figure 10) as a measure of relative abundance cannot be reliably used in evaluating the Georges Bank cod stock size. The catch per day indices show a steady increase since 1967, while all other indications of abundance (especially the virtual population analysis) show a contradictory pattern. Regression of the catch per effort data with the virtual population fishing mortality values results in a relationship which suggests that as more effort is placed in the fishery, the proportion of the population that is harvested decreases. This situation is obviously counter-intuitive (i.e., more effort should result in a greater fraction of the population that is removed), and implies the unsuitability of commercial catch per day data as a cod abundance indicator. This situation is a consequence of the shift in taking cod as an incidental catch in the haddock fishery (Figure 4 again) to taking cod as a directed catch.

Gulf of Maine - Bottom trawl survey and commercial market category size composition data (Figures 11 and 12) indicate that one strong year class (1971) and two moderately strong year classes (1973 and 1974) have appeared since 1970. These first appear in the trawl surveys as young-of-the-year fish (<10 cm; <4 in.) and later seen in the commercial catch as 3-year old scrod (note that Gulf of Maine cod take 3 years to reach the same size that Georges Bank cod attain in 2 years). This accounts for the sharp increase in the percentage of scrod in recent year landings. Evident also in both the commercial and survey data is the general reduction in the percent of large cod in the catch from 1971-73.

The 1977 survey abundance indices (both numbers and pounds per tow) increased from 1976; the weight per tow index was the highest since 1971. The juvenile fish abundance index, however, remained at a very low level relative to earlier years. The virtual absence of fish less than 20 cm (8 inches) in the 1975-1977 surveys (Figure 11 again) implies poor recruitment during the last three years, and further suggests that the currently harvested age-groups will have to sustain the fishery through at least 1980.

V. Optimum Yield

Georges Bank - The reported 1977 USA commercial cod landings were 19,750 tons, a 36% increase from 1976, and the highest since 1946. Coupled with Canadian landings of 5,430 tons, the 1977 commercial landings totalled 25,180 tons, and exceeded the 1977 commercial OY by 26%. Additionally, informal reports by US fishermen suggested that considerable amounts of scrod cod were discarded (unreported). Although the exact amount and age composition of these discards is unknown, the 1978 OY was determined by estimating four different discard levels in 1977: (1) no discards; (2) discards equal to 15% of the reported US commercial catch; (3) discards equal to 30% of the reported US commercial catch, and (4) discards equal to 50% of the reported US commercial catch. The estimated discards were apportioned in age groups 2 and 3 (scrod) and these additional removals added to the commercial catch to give four different estimates of the 1977 landings (the 1977 recreational landings were assumed to be 10,000 tons and were considered in the analyses along with the commercial harvest).

Four levels of 1978 fishery mortality were evaluated: (1) the F value that would maintain the 1979 total stock biomass equal to the beginning 1978 total stock biomass; (2) the F value that would produce a 10% increase in 1979 total stock biomass; (3) the F value that results in maximum yield per fish recruiting to the fishery (i.e., $F_{max} = 0.3$); and (4) an F value that is lower than F_{max} which would result in a higher average stock biomass and a higher probability of stable recruitment (i.e., $F_{0.1} = 0.18$).

Assuming no discard occurred in 1977 (highly unlikely), an OY of 28,300 tons in 1978 would maintain the 1978 stock size in 1979 (Table 2 Case 1). Alternatively, if discards equalled 30% of the reported USA commercial 1977 catch and a 10% increase in 1979 total stock size is desired, the 1978 OY would be about 20,800 tons (Table 2 - Case 3). In this latter case, if only a 5% increase in 1979 stock size is desired, the 1978 OY would be about 23,000 tons.

Gulf of Maine - The reported 1977 USA commercial cod landings were 10,291 tons, a 4% increase from 1976, and the highest in the fishery since 1945. The 1977 commercial catch exceeded the 1977 OY of 5,000 tons by 106%.

The 1978 OY of 7,000 tons corresponds to a catch intermediate between F_{max} (8,250 tons) and $F_{0.1}$ (5,230 tons), and represents a reduction in fishing mortality from 1977 (slightly above F_{max}). The poor recruitment evident since 1975 makes this reduction in F especially prudent.

COD - LIFE HISTORY SUMMARY

DISTRIBUTION = NORTH CAROLINA TO BAFFIN ISLAND, SOUTHERN GREENLAND AND ICELAND, BARENTS SEA, BAY OF BISCAY, AND COASTAL EUROPEAN WATERS

HABITAT: NEARSHORE SURF AREAS TO DEPTHS EXCEEDING 200 FATHOMS.
BOTTOM TYPE - ROCKY, PEBBLY OR FIRM CLAY, OFTEN ASSOCIATED WITH LEDGES AND SHOALS

TEMPERATURE RANGE: 0-10°C (32-50°F)

REPRODUCTION: OPTIMUM SPAWNING TEMPERATURES: 5-7°C (DEC.-APRIL)
SPAWNING OCCURS NEAR BOTTOM (20-40 FATHOMS) EGGS AND LARVAE ARE PELAGIC

HATCHING OCCURS IN 2-4 WEEKS

FECUNDITY: 3-9 MILLION EGGS PER FEMALE

AGE AT MATURITY: 3-6 YEARS OLD

MAXIMUM AGE: ABOUT 22 YEARS

FOOD: OMNIVOROUS

LARVAE - PLANKTON

JUVENILES - CRUSTACEANS (CLAMS, CRABS, MOLLUSKS)

ADULTS - FISH (HERRING, GADIDS, AND OTHERS) AND CRUSTACEANS (CRABS AND SHRIMP)

GROWTH: STEADY INCREMENTS TO AGES IN EXCESS OF 15 YEARS.

AVERAGE SIZE: 5-10 KG

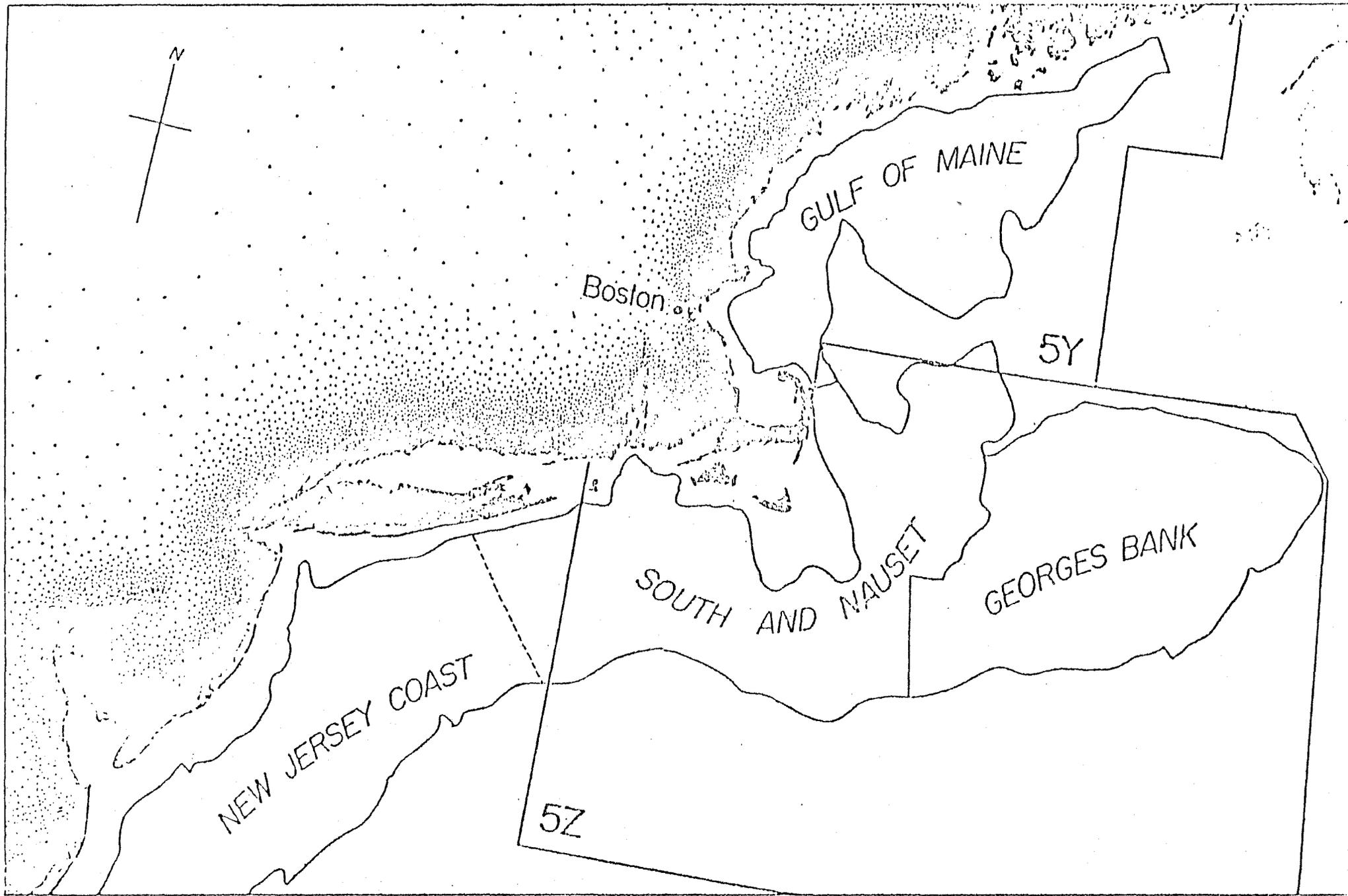
RECORD SIZE: 211 LBS

MIGRATIONS: SOUTH AND WESTERLY (SHOALER WATERS) IN WINTER AND EARLY SPRING. NORTH AND EASTERLY (DEEPER WATERS) IN LATE SPRING AND SUMMER.

Table 2. Projected Atlantic cod catch in 1978 from the Georges Bank stock (ICNAF Div. 52+SA 6) under four cases concerning the estimated 1978 stock size (derived from four estimates of the 1977 US commercial catch). The 1978 fishing mortality values were chosen to provide catches in 1978 that would (1) maintain the stock size, (2) produce a 10% increase in total stock size; and give changes at F_{max} and $F_{0.1}$. Total stock sizes (age 1+) and spawning stock sizes (age 3+) in 1978 and the percentage changes (by weight) from 1978 are also given. All catch and stock sizes are in metric tons.

	1978		1978 Catch (tons)	1979		% Change in	
	Total stock size	Spawning stock size		Total stock size	Spawning stock size	Total stock size	Spawning stock size
<u>Case 1</u>	77,557	61,578					
0% (F=.499)			28,337	77,569	64,118	0.0	+ 4.1
10% (F=.369)			22,098	85,315	71,837	+10.0	+16.7
F_{max} (F=.300)			18,497	89,818	76,326	+15.8	+24.0
$F_{0.1}$ (F=.180)			11,681	98,367	84,851	+26.8	+37.8
<u>Case 2</u>	74,208	58,229					
0% (F=.510)			27,453	74,218	60,769	0.0	+ 4.4
10% (F=.378)			21,470	81,624	68,148	+10.0	+17.0
F_{max} (F=.300)			17,606	86,440	72,948	+16.5	+25.3
$F_{0.1}$ (F=.180)			11,115	94,559	81,043	+27.4	+39.2
<u>Case 3</u>	70,876	54,897					
0% (F=.522)			26,480	70,896	57,449	0.0	+ 4.6
10% (F=.388)			20,844	77,953	64,479	+10.0	+17.5
F_{max} (F=.300)			16,721	83,079	69,587	+17.2	+26.8
$F_{0.1}$ (F=.180)			10,554	90,769	77,253	+28.1	+40.7
<u>Case 4</u>	66,462	50,483					
0% (F=.541)			25,427	66,463	53,020	0.0	+ 5.0
10% (F=.403)			20,011	73,102	59,631	+10.0	+18.1
F_{max} (F=.300)			15,547	78,626	65,134	+10.3	+29.0
$F_{0.1}$ (F=.180)			9,810	85,748	72,232	+29.0	+43.1

FIGURE 2 .



COD STOCK AREAS (Wise, J.P., 1962)

FIGURE 5.

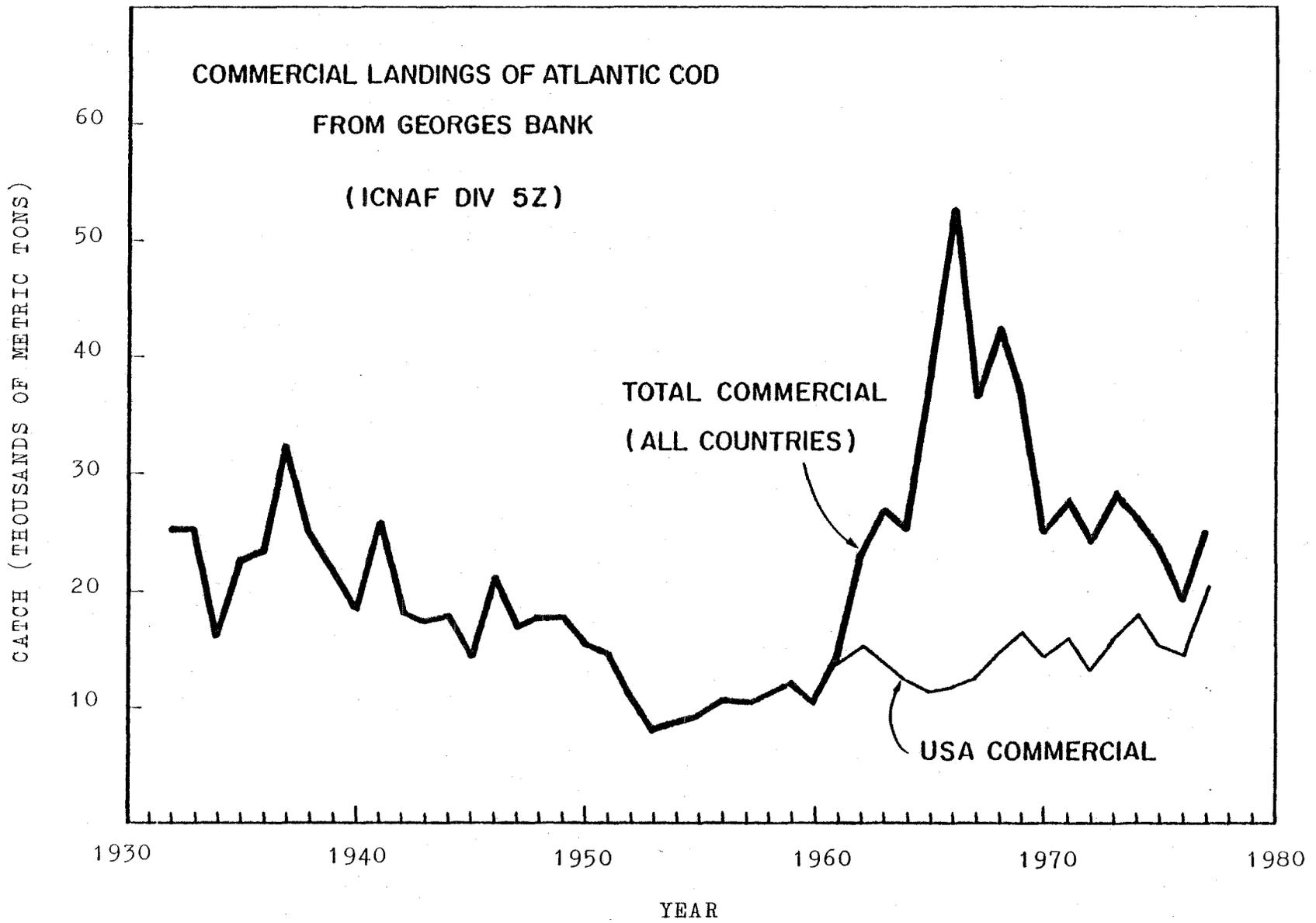


FIGURE 4.

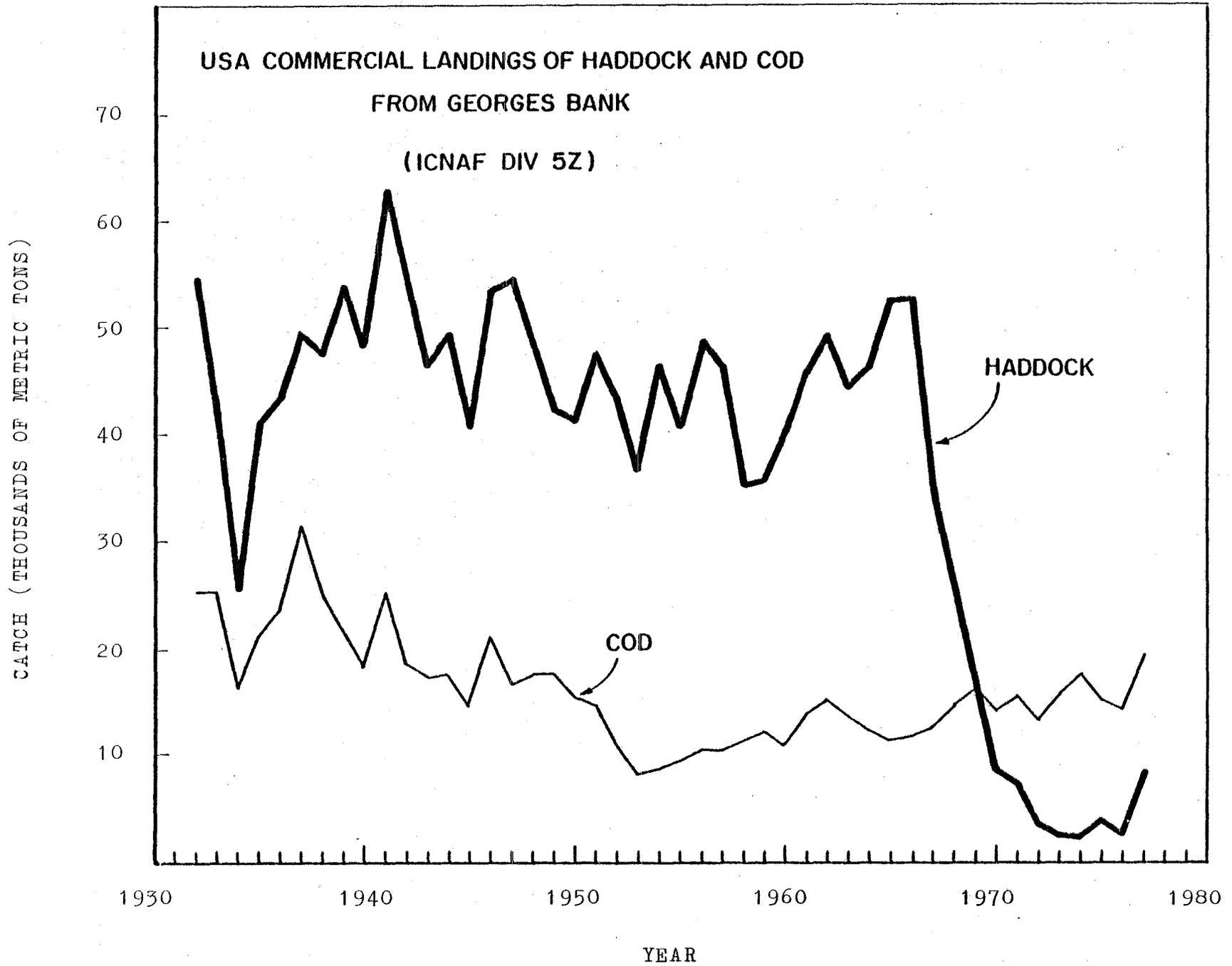
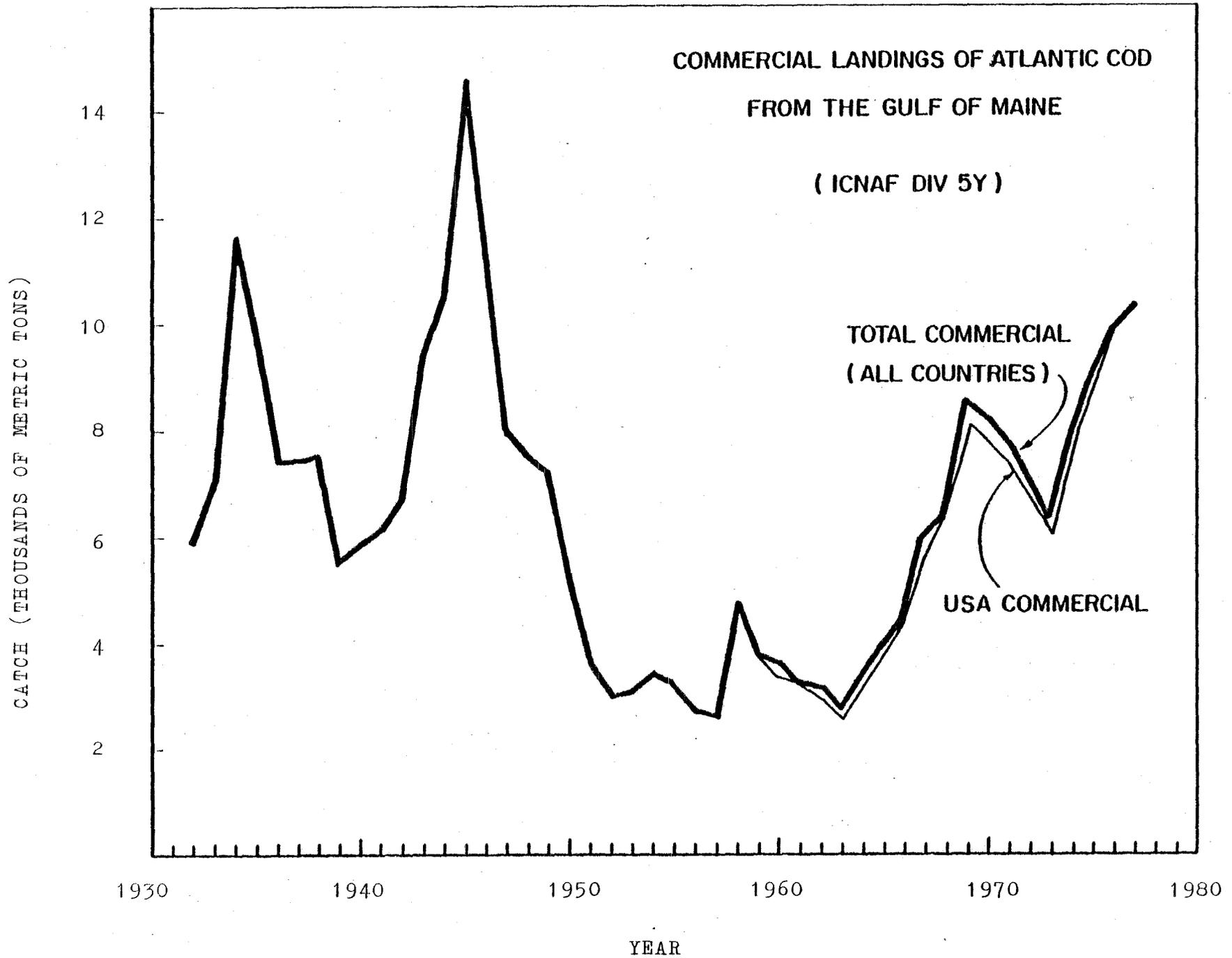
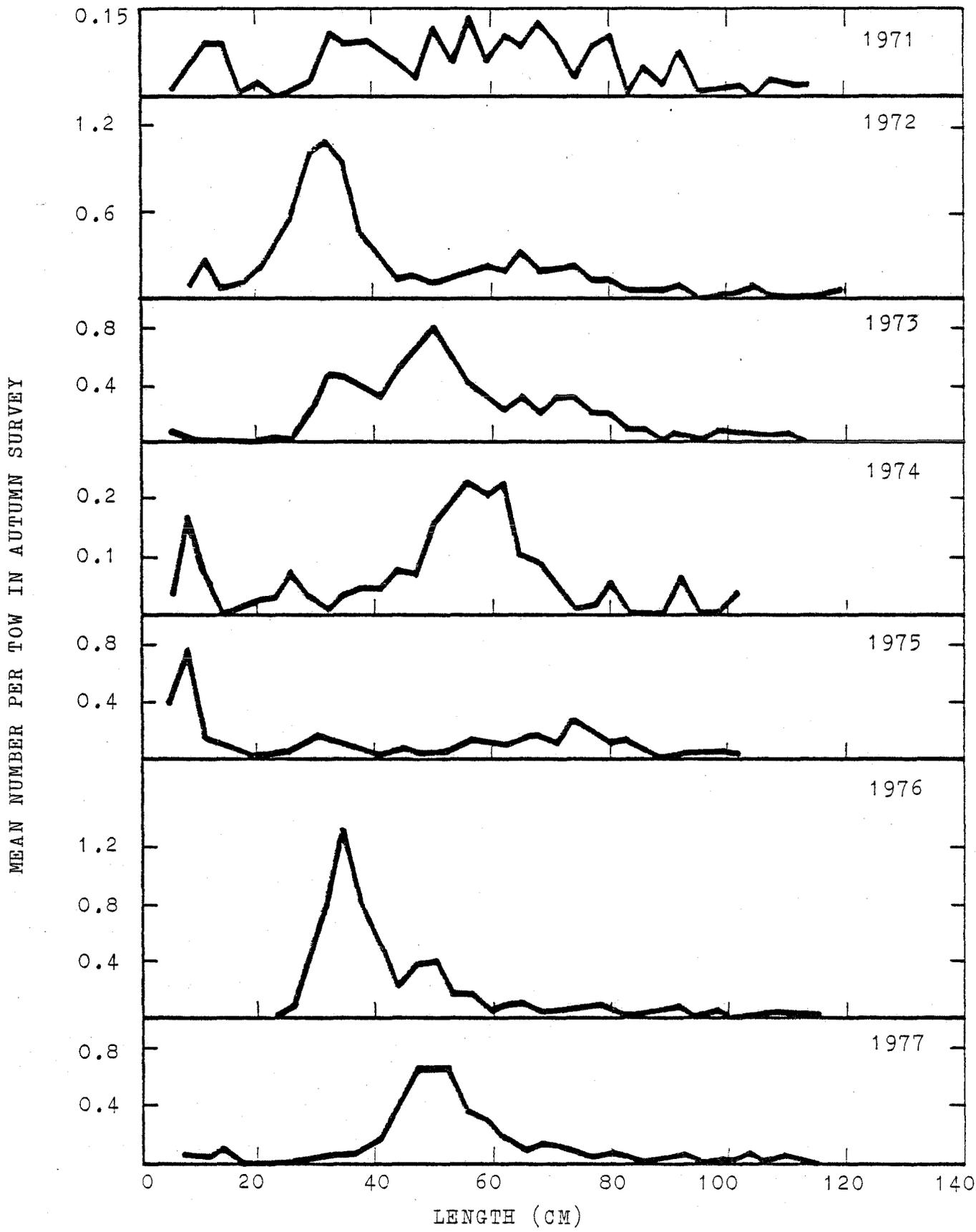


FIGURE 5.



GEORGES BANK COD - SURVEY DATA



GEORGES BANK COD COMMERCIAL
USA CATCH
QUARTER 3

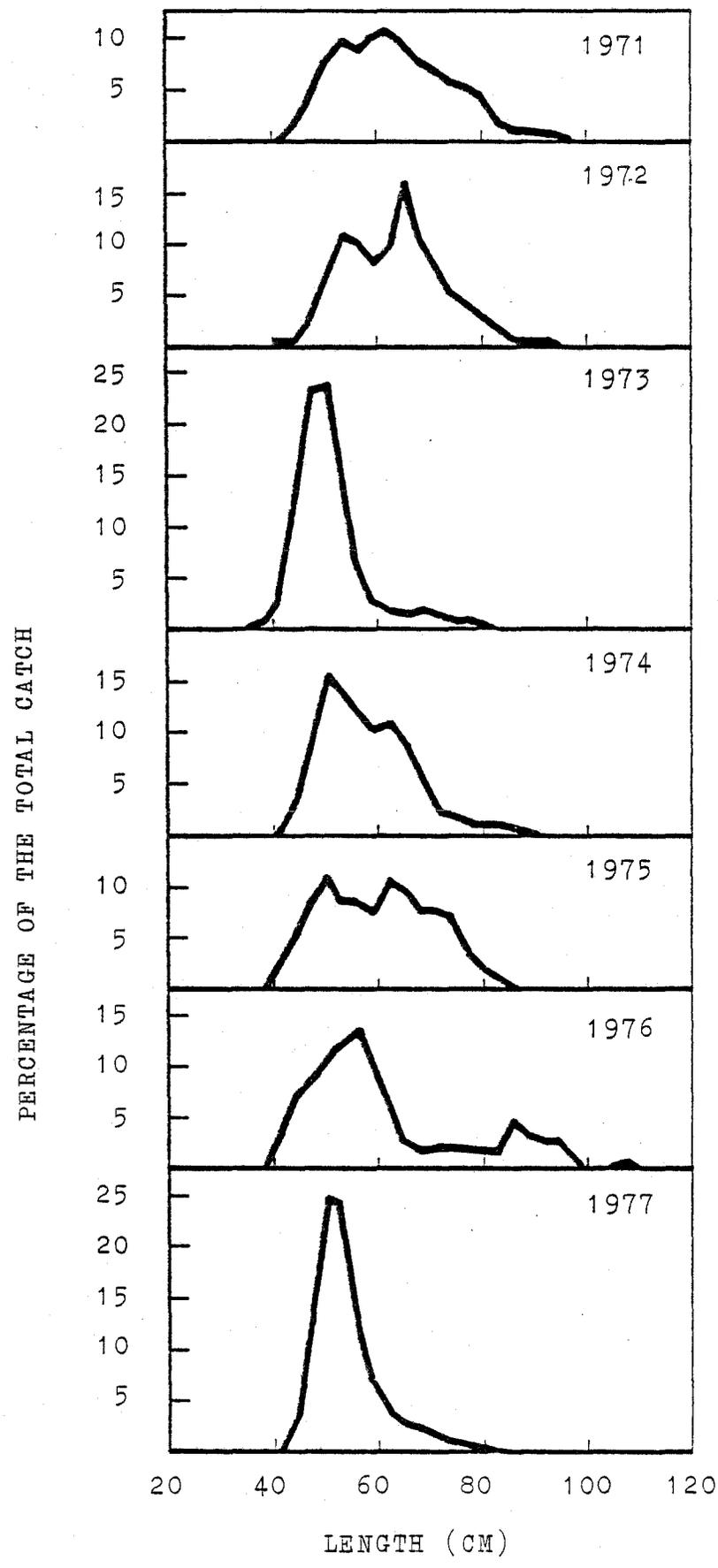


FIGURE 8.

ATLANTIC COD LANDINGS - GEORGES BANK
BY MARKET CATEGORY, 1971 - 1977

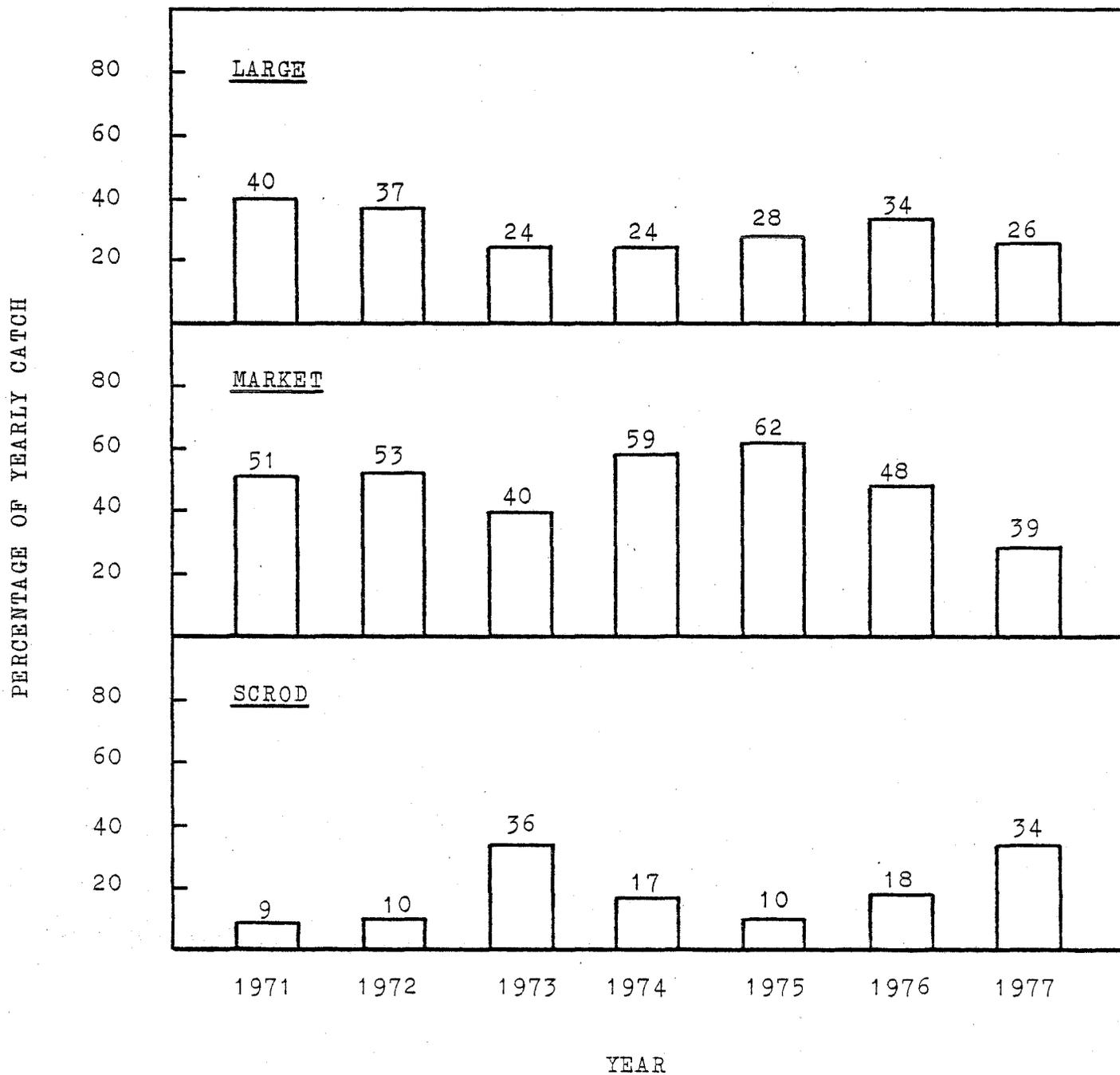


FIGURE 9.

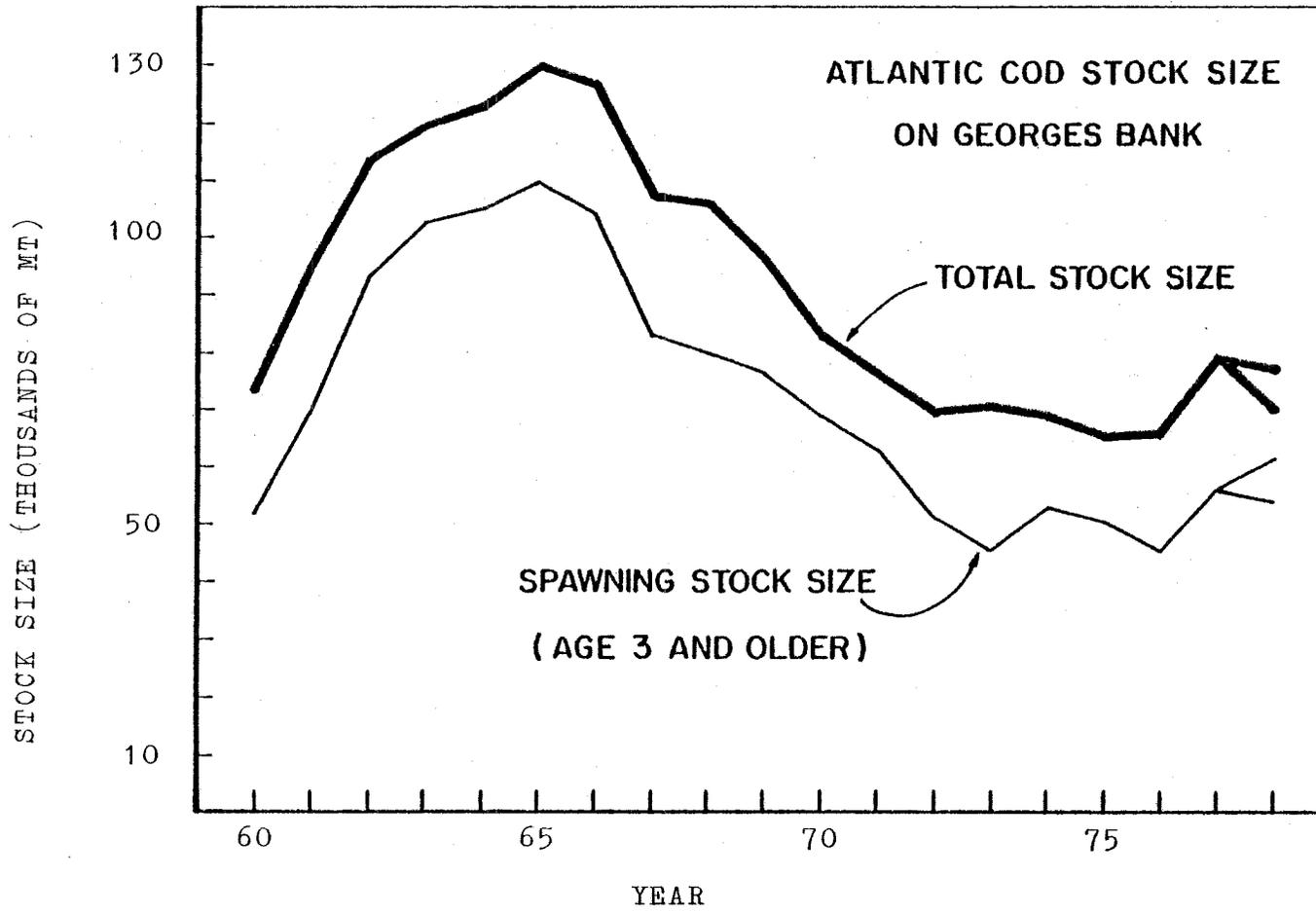
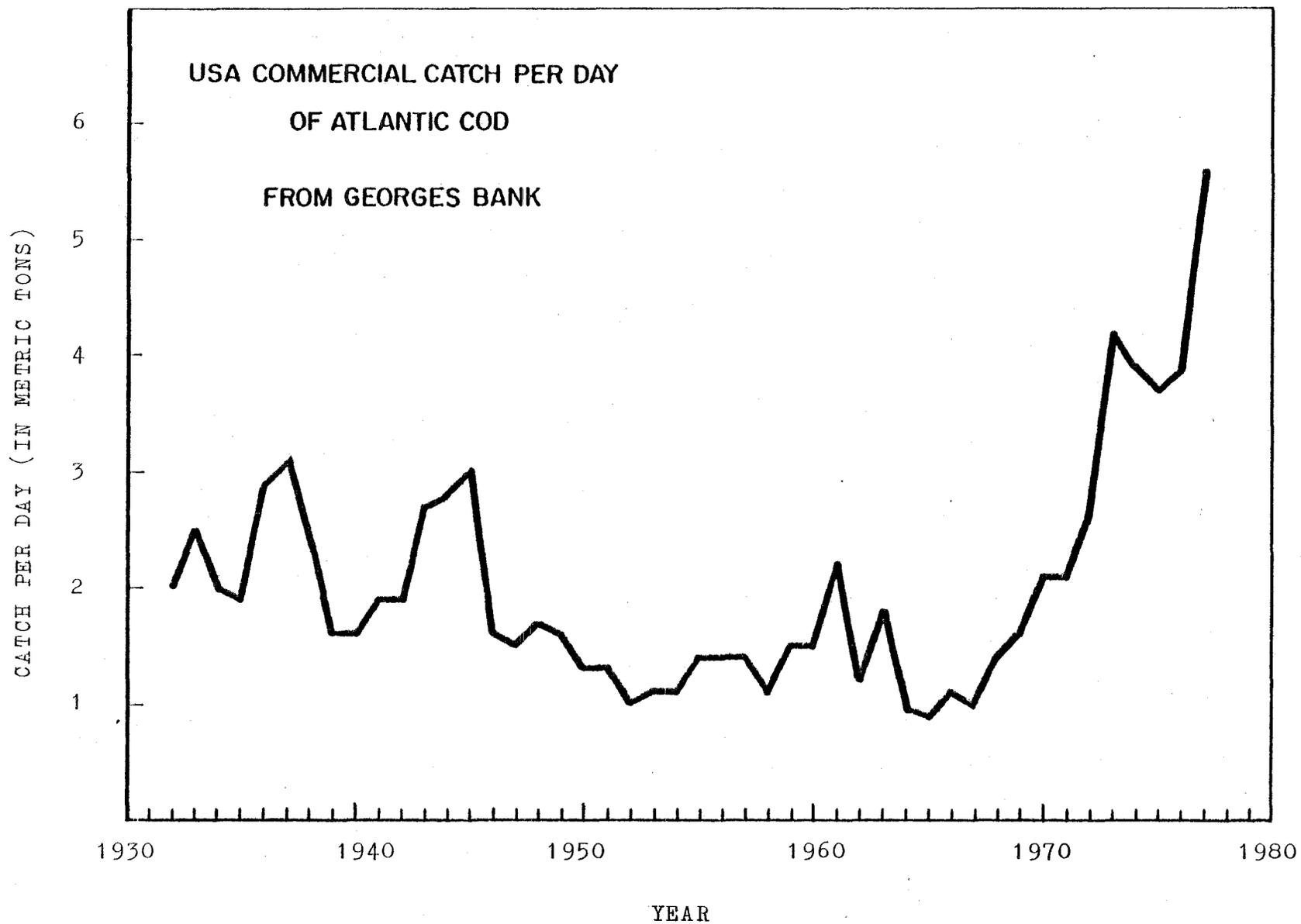


FIGURE 10.



GULF OF MAINE COD - SURVEY DATA

MEAN NUMBER PER TOW IN AUTUMN SURVEY

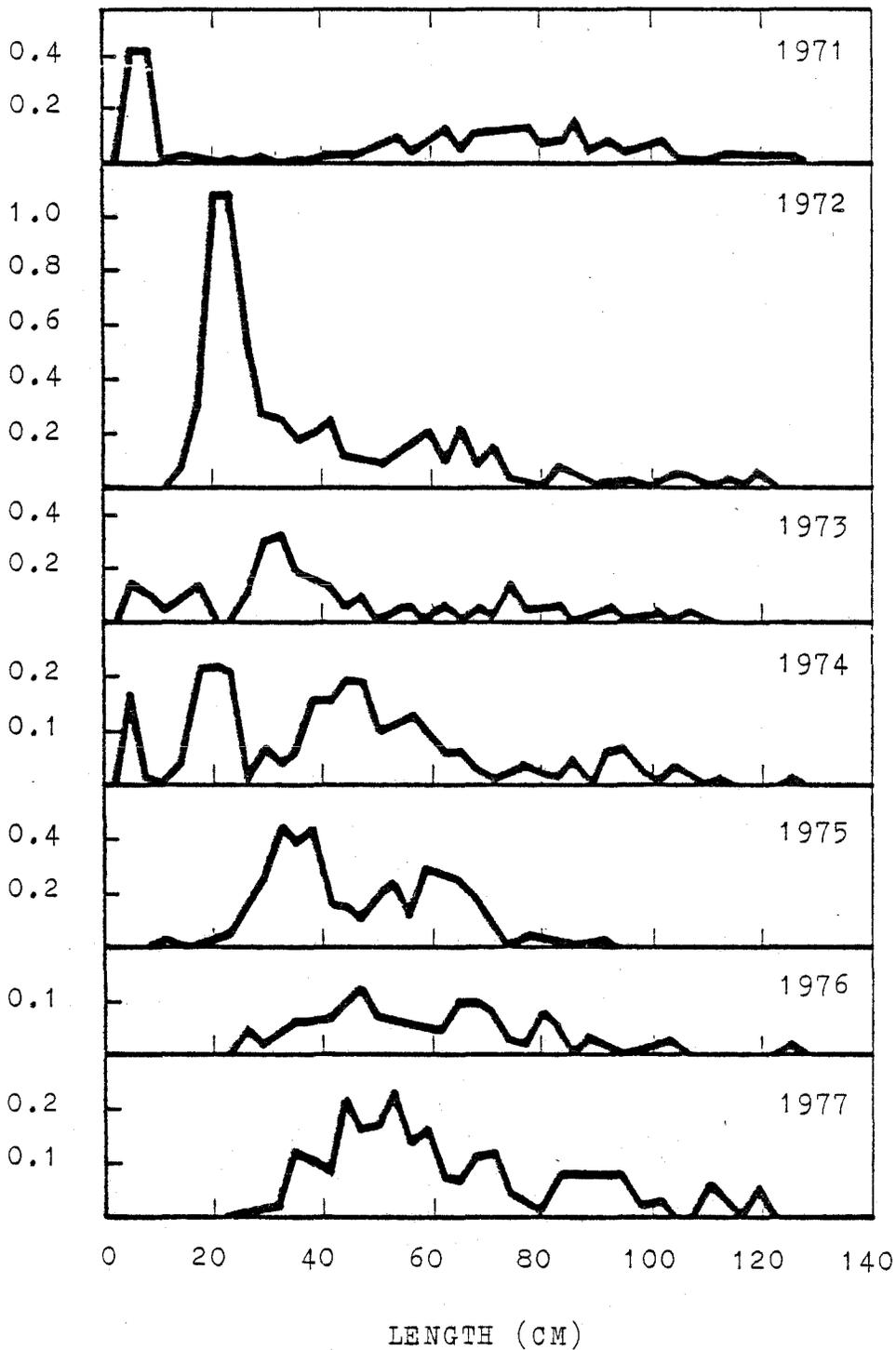


FIGURE 12.

ATLANTIC COD LANDINGS - GULF OF MAINE
BY MARKET CATEGORY, 1971 - 1977

