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Review and Status of the Southern New England-Middle Atlantic Atlantic cod, *Gadus morhua*, Populations

by

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TABLE OF CONTENTS

	Page
Introduction	1
Historical Perspective	2
Commercial Fishery	2
Recreational Fishery	7
Management and Regulatory Actions	10
Management Under ICNAF	10
Management Under the Fishery Conservation and Management Act (FCMA)	11
Geographical and Seasonal Distribution	15
Research Vessel Offshore Bottom Trawl Survey Catches	18
Sampling Intensity and Total Number and Weight of Cod Catches	18
Research Vessel Relative Abundance Indices	19
Total Mortality Estimates	23
Growth	24
Yield Per Recruit	26
Commercial Fishery	27
Distribution of USA Landings by Gear	27
Seasonal Trends in Landings	27
USA Commercial Effort and Catch	28
USA Commercial Catch Per Effort	31
Commercial Catch Composition	32
Discussion	33
References	35
Tables	40
Figures	65

Introduction

The Atlantic cod, *Gadus morhua*, is distributed in the Northwest Atlantic from Port Burwell, West Greenland to Cape Lookout, North Carolina (Wise 1958; Leim and Scott 1966). Throughout its range, cod is fished both commercially and for recreational purposes. In U.S. Atlantic waters, four major groups of cod have been recognized (Wise 1962): (1) Georges Bank; (2) Gulf of Maine; (3) Southern New England and South Channel; and (4) the New Jersey cod which spend the summer in Southern New England. Tagging studies (Smith 1902; Schroeder 1930; North American Council on Fishery Investigations 1932, 1935; Wise 1962), parasite infestation investigations (Sherman and Wise 1961), and growth rate analyses (Penttila and Gifford 1976) indicate that minimal interchange occurs between the Gulf of Maine and Georges Bank groups, but that extensive mixing prevails between the two groups of cod south and west of Nantucket Shoals. In this latter region, a seasonal movement of fish to the southwest occurs in the autumn followed by a northeasterly return in spring. Wise (1958) postulated that the autumn southwesterly movement was not a migration of native Nantucket fish [as concluded by Schroeder (1930)] but rather a return of the New Jersey-Middle Atlantic cod to their native grounds for winter spawning. The presence of ripe spawning individuals off the New Jersey coast (Smith 1902; Schroeder 1930; Wise 1958) and the occurrence of cod eggs and larvae as far south as North Carolina (Schroeder 1930; Berrien et al. 1978) suggest the possibility that cod in the Middle Atlantic may comprise a genetically distinct subpopulation, separate from those groupings found further north (Wise 1962). However, the origin and fate of Middle Atlantic cod eggs and larvae have yet to be delineated, and hence the existence of the subpopulation remains to be established.

Previous reports on the cod populations south and west of Georges Bank have generally been limited to natural history accounts (Goode 1884, 1887; Nichols and Breder 1927; Hildebrand and Schroeder 1928; Hardy 1978); fisheries descriptions and statistics (Earll 1887; Mather 1887; Power 1960, Jensen and Murray 1965; McHugh 1972, 1977; Jensen 1974a, 1974b, 1976, 1977; Gusey 1976; McHugh and Williams 1976; McHugh and Gunter 1978), and tagging and migration studies (Smith 1902; Schroeder 1930; Wise 1958, 1962). Other than Schroeder's (1930) classic treatise on the migrations and life history dynamics of Southern New England cod, limited research effort has been expended in more thoroughly evaluating the population dynamics of cod groups south of Georges Bank.

This report presents a review and analysis of the status of the Southern New England-Middle Atlantic cod populations and includes data on: (1) historical trends in both the commercial and recreational fisheries; (2) management and regulatory regimens and actions; (3) geographical and seasonal distribution of the species; (4) research vessel bottom trawl survey catch results; (4) total mortality estimates 1973-1978; (5) growth; (6) yield per recruit; (7) commercial fishery trends in landings, catch per effort, and catch composition; and (8) affinities with more northerly cod populations.

Historical Perspective

Commercial Fishery

The potential for cod fisheries in the Middle Atlantic and Chesapeake Bay states was first recognized by Dutch visitors to New Netherlands and Virginia colonists during the early 1600's (Pearson 1972: 682,727,822). Most early accounts related observations on sizable quantities of cod off Long Island, New Jersey, and Delaware Bay during the winter:

Now give my leave to acquaint you a little how things go here at York. Trials have been made several times this spring for codfish with very good success. A small ketch sent out by the Governor has found several good fishing banks; amongst the rest, one not above two or three leagues from Sandy Hook on which in a few hours four men took eleven or twelve hundred excellent good cod the last time they were out... (Letter from Mr. Maverick to Col. Nicolls, July 5, 1667. Printed in Doc. Rel. Col. Hist. N.Y. by John R. Brodhead, Vol. 3, p. 182. Albany, 1853-58.)

There is also found without our [*Delaware*] *bay to the northward an excellent fishing bank for cod and ling as good as can be eaten and of a kind that will keep a whole year in ships' hold with little care; a trial whereof I now have brought over with me.* (The Relation of the Lord de la Ware by Thomas West, London, 1611. Reprinted in Narratives of Early Virginia, 1606-1625, edited by L. G. Tyler, p. 213, New York, 1907.)

They call the other [*bay*] *the Delaware, where the entire year there is the fishing for codfish but not so profitable, except only in the cold months...* (A Relation of the Colony of the Lord Baron of Baltimore, in Maryland, near Virginia by Andrew White, London 1634. Reprinted in Tracts and Other Papers. Collected by Peter Force, Vol. 4, pp. 5-18. Washington, 1844.)

Collins and Rathbun (1887) reviewed the fishery grounds for cod south of Georges Bank and noted that commercial cod fisheries existed off Southern New England, Rhode Island, Long Island, the New Jersey coast, the Delaware coast, and along the eastern coast of Virginia. Detailed descriptions of

the major Southern New England-Middle Atlantic cod fisheries active during the late 1800's are provided in Clark (1887a, 1887b, 1887c), Mather (1887), and Earll (1887).

Commercial landings records of cod from Southern New England and Middle Atlantic areas are available back to 1880 (Jensen and Murray 1965; Lyles 1967; McHugh and Williams 1976). Annual landings (Rhode Island to Virginia) have been relatively small and variable, ranging from a minimum of 409 metric tons in 1902 to a maximum of 9,625 metric tons in 1930 (Table 1). The southerly fisheries have never been large compared to cod landings from Georges Bank and northward; during the peak year of 1930, Southern New England-Middle Atlantic commercial cod catches comprised less than 19% (18.9) of the total reported domestic commercial cod landings. The average long term (1929-1978; prior to 1929, statistical accuracy of landings is suspect: Power 1968; McHugh and Williams 1976) USA commercial cod harvest south of Georges Bank is about 2,360 metric tons per year. In contrast, the average long-term USA annual commercial cod catch (1932-1975) of Georges Bank cod is about 16,000 metric tons, and the average annual USA commercial catch (1932-1975) of cod from the Gulf of Maine is about 6,200 metric tons (Serchuk et al. 1978).

Historically, the Southern New England-Middle Atlantic commercial cod fishery has been seasonal, with most of the catch taken in the winter. Largest landings occur from December through April, with peak catches normally taken between December and February (Jensen and Murray 1965). In the past, winter cod fisheries have extended as far south as the Chesapeake Bay region (Schroeder 1930); on some occasions, small incidental cod catches have even been taken off the North Carolina coast (Smith 1907; Pearson 1932).

Handlines and pound nets formerly were extensively used as principal gear in the southern cod fisheries, but have since been replaced by longlines, line trawls (trot lines), and otter trawls (Jensen and Murray 1965). Purse seines, bass pots, and gill nets have been occasionally used as well but have taken only negligible quantities of cod.

Traditionally, New York and New Jersey have accounted for the largest annual commercial cod landings harvested south of Georges Bank (Table 1). Since 1929, approximately 61% of the total commercial cod catch from Rhode Island to Virginia has been landed in New York and New Jersey. Excluding landings in Rhode Island and Connecticut (Southern New England states), New York and New Jersey have accounted for 97% (54% and 43%, respectively) of the reported US commercial cod landings in the Middle Atlantic region during 1929-1978.

Historical patterns of cod landings in Southern New England and Middle Atlantic areas are reflected in the annual trends of New York and New Jersey commercial cod catches (Figure 1). Peak landings were recorded in 1930 and 1938. After 1938, cod landings declined concomitant with reductions in the regional otter trawl fleets (McHugh 1972, 1978). A brief increase in landings was experienced in the late 1950's-early 1960's as a result of increased localized cod abundance (McHugh 1977). Since 1966, combined annual New York and New Jersey commercial cod catches have stabilized at relatively low levels (<400 metric tons).

In the Delaware and Chesapeake Bay regions, a trot line fishery for cod redeveloped during 1958-1965 when winter otter trawl landings of fluke (*Paralichthys dentatus*) and black sea bass (*Centropristis striata*) declined due to population reductions (June and Reintjes 1957; Jensen and Murray 1965).

Commercial cod landings in Delaware, Maryland, and Virginia reached 387 metric tons in 1961 (Table 1) but rapidly declined in succeeding years. From 1966-1978, only a total of 101 metric tons of cod were taken commercially south of New Jersey. Most of these cod were an incidental catch in the directed winter trawl fisheries for fluke and sea bass.

Although the majority of commercial cod landings reported from Rhode Island to Virginia can be considered as having been taken from Nantucket Shoals and southward, some of the larger vessels in Rhode Island, Connecticut, and New York fish on Georges Bank (ICNAF Subdiv. 5Ze) in the summer. Equally, a portion of the Massachusetts landings, particularly those landed in Cape Cod ports (i.e., Chatham; Jensen and Brigham 1963) are taken in the Nantucket Shoals region (ICNAF Subdiv. 5Zw). Hence, state landings statistics per se do not categorically reflect all commercial cod harvests south of Georges Bank. Since 1966, however, commercial cod landings taken from Block Island to Cape Hatteras (ICNAF Statistical Area 6) have been recorded by the International Commission for the Northwest Atlantic Fisheries (ICNAF). Beginning in 1968, ICNAF also categorized landings from Georges Bank (ICNAF Subdivision 5Ze) separately from those from Nantucket Shoals-Southern New England (ICNAF Subdivision 5Zw).

ICNAF commercial cod landing statistics, 1966-1978, from Subdivision 5Zw and Statistical Area 6, are presented by year and country in Table 2. Total annual landings (all countries, both areas) during 1968-1978 ranged between 742 metric tons (1977) and 3,193 metric tons (1973), and averaged 2,045 metric tons per annum. Total annual landings from Southern New England have tended to be several times larger than those from the Middle Atlantic; during 1968-1978, commercial cod landings from Southern New England accounted for

77% of the reported catch from Subdiv. 5Zw + SA 6. This pattern was similar for both the USA and foreign fisheries (1968-1978: 74% of USA catches from 5Zw + SA 6 were in 5Zw; 84% of the foreign catches from 5Zw + SA 6 were taken in 5Zw).

Yearly USA commercial cod landings, 1968-1978, south of Georges Bank have varied between 693 metric tons (1976) and 1,962 metric tons (1978), and averaged 1,377 metric tons (Table 2). The 11-year annual mean Southern New England cod catch is 1,013 metric tons, while Middle Atlantic landings have averaged only 364 metric tons per year. Annual USA cod catches in the Middle Atlantic, however, have not fluctuated as greatly as those from Southern New England (Table 2).

Foreign cod landings in areas south of Georges Bank reached greatest levels during 1971-1973 when yearly catches averaged 1,462 metric tons. These increased harvests resulted from Spanish pair trawling catches from Subdiv. 5Zw in 1971 and 1972 (1,067 and 1,078 metric tons, respectively, listed in Other Category in Table 2), and a large USSR catch (893 metric tons) from Subdiv. 5Zw in 1972. Since 1974, annual foreign landings have rapidly declined. In 1978, no cod were reported in foreign fisheries operating in Subdiv. 5Zw or SA 6. This was not unexpected since the Fishery Management Plan for Atlantic Groundfish, implemented by the USA on March 15, 1977, prohibits foreign fishing for cod in the USA 200-mile Fishery Conservation Zone. Between 1968 and 1978, foreign cod landings from Southern New England and the Middle Atlantic comprised 33% of the total reported commercial cod catch in this region (Table 3).

Recreational Fishery

Historical data on recreational cod landings in the North Atlantic and Middle Atlantic regions are available from national saltwater angling surveys

conducted in 1960, 1965, and 1970 by the National Marine Fisheries Service through the Bureau of the Census (Clark 1962; Deuel and Clark 1968; Deuel 1973) and from a regional survey of the Northeastern Coastal United States conducted in 1974 (Ridgely and Deuel 1975; Pileggi and Thompson 1979; Deuel unpub. data). Estimated recreational cod catches from these surveys were (in metric tons):

Year	Maine-New York	New Jersey-North Carolina	Total
1960	11,426	2,590	14,016
1965	13,144	421	13,565
1970	16,188	104	16,292
1974	10,794	1,525 (+49)	12,368

Interpretation and comparison of the survey estimates are complicated because of methodological differences between surveys, small sample sizes, memory bias errors, and the lack of precise data on area of capture (McHugh 1976; Pileggi and Thompson 1979). Moreover, since recreational cod landings were not reported by state in the first three surveys, derivation of estimates for Southern New England and Middle Atlantic waters is difficult to accomplish. Recreational landings were estimated by state in the 1974 survey, however, and indicated a recreational cod catch of 8,504 metric tons from Rhode Island to New Jersey. Comparison of this estimate with the corresponding total domestic commercial cod catch recorded in the region in 1974 (Table 1: 1,848 metric tons) indicated that the Southern New England-Middle Atlantic recreational cod catch was about 4.5 times as large as the regional domestic commercial catch, and threefold greater than the total 1974 commercial cod catch (all countries) in Subdiv. 5Zw + SA 6 (Table 2). The 1960 and 1965 Middle Atlantic (New Jersey to North Carolina) recreational cod catch estimates approximate

the reported domestic catch from Rhode Island to Virginia for each of these years (Table 1: 1960 - 2,811 tons; 1965 - 517 tons). Since, however, the New York and Rhode Island recreational landings have been included with the New England landings in the survey results, it is probable that, had these been included in the Middle Atlantic landings, the recreational cod catch from Rhode Island south would markedly exceed the commercial cod catch in this region. This supposition is based on two observations: (1) in the 1974 recreational survey, the New York and Rhode Island estimated catches accounted for 65% of the total Maine-New York (North Atlantic Region in the 1960, 1965, and 1970 surveys) recreational cod catch, and (2) the recreational cod catch at Montauk, Long Island alone has been estimated at about 2,700 metric tons per year (Jensen 1974a, 1974b, 1977). Clearly, the Southern New England-Middle Atlantic recreational cod fishery has been substantial in magnitude.

In New York, cod dominates the winter marine sport fishery (Mohr 1976). Angling occurs nearly year-round on Cox Ledge and near Block Island, but the greatest sport catches are made during spring and autumn when the cod are moving from one ground to another (Jensen 1974b). The charter and party boat fishery at Montauk probably accounts for more than half of the New York recreational cod landings although large catches are also made by boats from Freeport, Sheepshead Bay, and Captree State Park (Mohr, 1976).

Other major ports in Southern New England and the New York Bight from which seasonal party boats fish for cod include Point Judith, Galilee, and Narragansett (Rhode Island); Niantic/Waterford, Groton, and New London (Connecticut), and Belmar (New Jersey). As localized cod abundance waxes and wanes, party and charter boats from other ports enter and leave the sportfishery.

Distribution of the recreational cod catch within Southern New England and the Middle Atlantic region is not precisely known, although the south shore of Long Island and the Cox Ledge-Block Island offing are certainly important sportfishing grounds. To obtain better data on marine recreational landings, the National Marine Fisheries Service began a new Marine Recreational Fisheries Survey in 1978. Results from the survey will be available in February 1980 (Pileggi and Thompson 1979). Marine recreational studies are also being conducted by various universities under contract with the NOAA Sea Grant Office (e.g., University of Rhode Island) to measure the economic and biological significance of marine sportfishing in particular states. As part of this latter program, two reports on marine recreational fishing in Rhode Island have already been published (McConnell and Smith 1979a, 1979b).

A detailed overview and description of the Northwest Atlantic recreational cod fisheries has recently been provided by Nicholson and Ruais (1979).

Management and Regulatory Actions

Management Under ICNAF

Regulatory measures for the Subarea 5 Atlantic cod fisheries were first implemented by ICNAF in March 1957 when a minimum cod end mesh regulation of 114 mm (4.5 in) became effective in the trawl fishery (Table 4). An incidental catch restriction of cod in fisheries using mesh sizes smaller than 114 mm (2,265 kg or 10% by weight of all fish on board a vessel per trip, whichever is greater) was enacted concurrently with the mesh size controls (Table 4). Both regulatory measures, which persisted with slight modifications through 1977, were instituted to increase potential yield per recruit by increasing the age at first capture as was similarly accomplished in the Georges Bank haddock fishery (Graham 1952; Graham and Premetz 1955). In 1974, the minimum mesh size in the Subarea 5 cod, haddock, and yellowtail flounder trawl

fisheries was increased to 130 mm (5.1 in) in the cod end, and to 114 mm (4.5 in) in other sections of the net.

Closed seasons and areas were established beginning in 1970. Two principal haddock spawning areas on Georges Bank (Figure 2) were closed in March and April (also during May since 1972: Table 4) to gear capable of taking demersal species (including cod) to reduce fishing mortality and possibly enhance haddock recruitment (ICNAF Redbook 1969, Part I: 34). The coexistence of cod with haddock and the single integral fishery for both species (ICNAF Redbook 1968, Part I: 57-59) were premises for expecting reductions in catch from the Subarea 5 cod stock by regulation of the directed haddock fishery. Additional area and seasonal closures were introduced in May 1974 and July 1975 prohibiting demersal fishing by larger vessels within prescribed regions of Southern New England, the Gulf of Maine, Georges Bank, and Statistical Area 6 (Figures 3a and 3b).

Increased exploitation of the Subarea 5 cod stock during the mid-1960's, particularly by foreign distant water fleets, resulted in both growth overfishing (Brown 1971), and lowered stock abundance during 1964-1971 than for the period 1931-1963 (Brown and Heyerdahl 1972). Resultingly, annual quota management for Subdivision 5Ze and 5Zw cod was initiated under ICNAF in 1973 through adoption of a Total Allowable Catch (TAC) of 35,000 metric tons (Table 4). This TAC was maintained yearly during 1974-1976 but was reduced to 20,000 tons for 1977 since fishing mortality levels remained above that providing maximum yield per recruit (F_{max}) (Penttila and Gifford 1976).

Management Under the Fishery Conservation and Management Act (FCMA)

Exclusive USA management authority over all fishery resources within a 200-mile Fishery Conservation Zone (FCZ) from the coastal states became

effective March 1, 1977, through the Fishery Conservation and Management Act of 1976 (P.L. 94-265). Under provisions of the Act, the New England Regional Fishery Management Council (NERFMC) was established, and assumed jurisdiction over all Atlantic cod stocks in ICNAF Subarea 5 and Statistical Area 6. The NERFMC proposed that the New England and Middle Atlantic cod populations be managed as two distinct units: (1) Gulf of Maine: FCZ north of 42°20'N latitude plus that area south of 42°20'N latitude which is west of 70°00' longitude and which 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.

Initial management regulations were implemented on an emergency basis on March 15, 1977 (Table 5). These measures specified mesh size restrictions (130 mm cod end meshes; 114 mm meshes in other net parts), fish size restrictions (minimum length of cod of 40.6 cm), closed areas and seasons (same as under ICNAF: Figure 2), and annual commercial and recreational catch quotas (Georges Bank and South: 20,000 tons commercial; 10,000 tons recreational/Gulf of Maine: 5,000 tons commercial; 2,300 tons recreational). These emergency regulations remained in effect until June 13, 1977 when final regulations were enacted through implementation of the Atlantic Groundfish Fishery Management Plan (FMP). The final regulations deleted quotas in the recreational cod fisheries but retained all previous provisions pertaining to cod.

By summer 1977 the accumulative cod catch had reached 80% of the established quota levels, prompting closure of the directed cod fisheries in the Gulf of Maine and on Georges Bank and southward on July 8 and August 22, respectively. Incidental fisheries continued afterward under by-catch provisions allowing 2.5 tons per trip of cod or 10% by weight of all other fish on board, whichever was greater. Effective November 3, 1977, the 1977

cod catch quotas were raised (Georges Bank and South: 21,650 tons commercial/ Gulf of Maine: 12,000 tons commercial) by emergency amendment to the FMP citing economic hardship as justification for permitting further incidental cod catches. The incidental catch limitations were changed from per-trip to a per-day-at-sea basis and differentially applied among three vessel tonnage size-classes (<50 GRT, 50-125 GRT, and >125 GRT). When the emergency amendment expired on 18 December, the quota provisions reverted back to those implemented on 13 June; since these had already been exceeded, all commercial groundfisheries in the FCZ were closed on 24 December for the rest of the calendar year.

During the first quarter of 1978 (1 January-31 March), emergency regulations were in force implementing the final regulations previously enacted on 13 June 1977. First quarter cod landings reached 50% of the first quarter allocations (Georges Bank and South: 4,163 tons commercial/Gulf of Maine: 1,250 tons commercial) on 15 February and under new closure criteria effected with the emergency regulations, the directed commercial cod fisheries were closed during March. Incidental cod fisheries were permitted until 19 March when the by-catch fisheries were closed for the remainder of the month because of attainment of the quarterly cod quotas.

Since the original Atlantic Groundfish FMP expired on 31 March 1978, interim emergency regulations implementing a new FMP were enacted on 1 April. New cod quotas for 1978 were established (Georges Bank and South: 22,000 tons commercial/Gulf of Maine: 6,000 tons commercial; 2,500 tons recreational charter and headboat fishery), quarterly allocations instituted, and greater flexibility provided for adjusting quarterly quotas and landing restrictions to avoid premature closures. Effective 30 April, weekly rather than daily

trip landing restrictions were introduced within redefined vessel tonnage-class categories (≤60 GRT, 61-125 GRT, ≥126 GRT, and fixed gear vessels using hooks or gill nets). These weekly vessel class landing restrictions were readjusted downward on 7 May and again on 2 July. Final regulations reflecting all of these amendments were enacted on 1 July.

On 23 July, additional emergency amendments to the FMP were implemented which included provisions for increasing the optimum yield (OY) for the Georges Bank and South cod stock from 22,000 tons to 26,000 tons (so as to include 4,000 tons for USA recreational and Canadian commercial fishing), increasing the OY for Gulf of Maine cod to 10,500 tons (so as to provide an additional 2,000 tons to the commercial quota), establishing a minimum mesh size of 140 mm (5½ in) for bottom-tending gill nets, and prohibiting discarding of the regulated groundfish species. Specific annual vessel tonnage class/gear type allocations were assigned based on historical landings data, and weekly vessel class catch limitations readjusted upward for the Georges Bank and South commercial cod fishery.

During July-September 1978, closures were instituted for various vessel gear/size classes in both the Georges Bank and South, and Gulf of Maine commercial cod fisheries as annual vessel class allocations were exceeded. On 1 October, the Atlantic Groundfish FMP was re-established to regulate fishing during a "fishing year" basis from 1 October 1978 to 30 September 1979 rather than a calendar year. The cod OY's and quotas proposed by the NERFMC in March 1978 were implemented, and modifications in the incidental cod catch limitations were enacted. All prior regulations in the Atlantic groundfish fishery were rescinded and replaced by re-promulgated regulations.

Vessel gear/size class closures continued to occur in the Georges Bank and South and Gulf of Maine commercial cod fisheries during November 1978-April 1979 as individual vessel classes attained their quarterly and annual cod quotas.

Currently, the NERFMC is in the process of formulating a more effective management plan for the Atlantic groundfish fishery. While this new FMP is being prepared, the NERFMC has proposed to amend the existing plan by: (1) extending the plan for another "fishing year" (until 30 September 1980) or until the new FMP is implemented; (2) revising OY's for the period 1 October 1979-30 September 1980 (Georges Bank and South cod: 35,000 tons/Gulf of Maine cod: 12,000 tons); (3) increasing the minimum cod end mesh size to 140 mm (5½ in) in Subarea 5Ze and the Gulf of Maine; (4) enacting a minimum legal size of cod (and haddock) in possession by harvesters and processors of 18 inches total length; and (5) increasing the OY's for the 1978-79 fishing year (Georges Bank and south: 34,960 tons/Gulf of Maine: 11,380 tons) so as to increase commercial quotas in the fourth quarter (1 July-30 September 1979) (Georges Bank and South: 8,960 tons/Gulf of Maine: 2,880 tons). This latter recommendation (new 1978/1979 OY's) was approved in early July 1979 and implemented by regulation on 22 July 1979 (Table 5).

Geographic and Seasonal Distribution

Average geographic and seasonal distributions of cod populations in Southern New England and the Middle Atlantic have been derived from plots of individual trawl catches taken in the time series of annual autumn (1963-1978) and spring (1968-1978) research vessel offshore bottom trawl surveys conducted by the Northeast Fisheries Center. These surveys employed a stratified random sampling design and sampled the continental shelf area

from Nova Scotia to Cape Hatteras at depths between 27-365 m (15-200 fm) (Figure 4). Survey methods, procedures, and gear are detailed in Grosslein (1969, 1974), Pierce and Hughes (1979), and Clark (1979).

Cumulative spring and autumn NEFC survey stations at which cod were taken (Figure 5) corroborate tagging study results (Smith 1902; Schroeder 1930; Wise 1962) indicating the presence of cod in Southern New England-Middle Atlantic waters in late autumn-early winter, followed by a northeasterly offshore occurrence in late spring. Cod have been taken in the spring surveys as far south as Virginia but never below northern New Jersey in the autumn. In both survey time-series, adult cod ($\geq$37 cm) have dominated the trawl catches; juvenile cod (<37 cm) accounted for 16% (134/849) of the total cod taken in the spring Southern New England-Middle Atlantic survey catches during 1968-1979, and only 11% (31/271) of the total autumn survey cod catches south of Georges Bank during 1963-1978 (Table 6).

Survey trawl stations where positive catches of juvenile cod have been taken in the spring and autumn surveys are presented in Figure 6. Southwest of Martha's Vineyard (strata 1-2, 5-6, 65, 69-70, and 73-74), juvenile cod were taken in only 11 spring trawl tows out of the 633 tows accomplished between 1968-1978. In the autumn surveys, 1963-1978, juvenile cod have never been caught offshore south of Fire Island, New York (strata 1), and appeared in only 16 of 559 trawl tows performed in Southern New England (strata 1, 5, 6, 9, and 10).

Since ripe spawning adults and cod eggs and larvae have been variously reported along and south of the New Jersey coast (Smith 1902; Schroeder 1930; Wise 1958; Berrien et al. 1978), the relative absence of juvenile cod in trawl catches in this region suggests that: (1) the southerly cod populations are not self-sustaining and hence depend on immigration of fish from the north;

or (2) offspring from southern spawning are concentrated shoalward of 27 m (15 fm) and thus normally unavailable for capture in the spring and autumn offshore bottom trawl surveys; or (3) offspring of southern spawning move northward, either as ichthyoplankton or nekton, and subsequently return southward as adults several years later.

Hypotheses 1 and 3 can only be evaluated through tagging of juvenile progeny from Middle Atlantic spawning and determination of the ensuing movement or migration of these individuals. To date, this remains to be accomplished. Hypothesis 2 can be investigated by examination of inshore bottom trawl survey catch data for the presence of juvenile cod. Such data are available from NEFC inshore research bottom trawl surveys conducted since 1972 from Block Island to Cape Hatteras in depths between 0-15 fms (0-27 m) (Table 7; Figure 7).

Between autumn 1972 and spring 1979, 17 inshore bottom trawl surveys were conducted occupying a total of 1,450 stations between Block Island and Cape Hatteras. A total of 268 cod was collected; of these only 17 were juveniles (<37 cm length) (Table 7). Hence, it is unlikely that offspring from southern cod spawning concentrate inshore in the Middle Atlantic region. Since juvenile cod have been taken in large numbers in inshore surveys of Massachusetts waters (Bruce Estrella, Massachusetts Division of Marine Fisheries, pers. comm.), the virtual absence of these life stages in southerly coastal (and offshore) areas implies that Wise's (1962) suggestion that "the New Jersey are a genetic subpopulation" is tentative at best. The genetic origin of cod found in the Middle Atlantic thus continues to remain an unresolved issue.

Research Vessel Offshore Bottom Trawl Survey Catches

Sampling Intensity and Total Number and Weight of Cod Catches

Historical trends in abundance of Southern New England-Middle Atlantic cod populations have been evaluated from both spring and autumn offshore bottom trawl surveys. Sampling strata in Southern New England and the Middle Atlantic (Figure 4) in which cod have never been taken in the survey time series were excluded from abundance analyses.

Twelve annual spring surveys (1968-1979) and 16 autumn surveys (1963-1978) have been conducted in Southern New England-Middle Atlantic waters. Cod have been caught in Strata 1-2, 5-6, 9-10, 65, 69-70, and 73-74 in the spring surveys and in Strata 1, 5, 6, 9, and 10 in the autumn surveys. In these areas, a total of 882 tows have been accomplished in the spring time series capturing 849 cod weighing 6,002 pounds (Tables 8-10); in the 16 autumn sampling efforts in Southern New England (no cod were ever captured south of Southern New England), a total of 559 tows have been made yielding 271 cod weighing 1,935 pounds (Table 11).

During both survey time series, sampling intensity has remained relatively constant (Table 12). An average of 74 tows have been performed annually in the spring in the Southern New England-Middle Atlantic "cod strata" (range: 58-101; median: 74). Annual autumn sampling intensity in the Southern New England "cod strata" has averaged 35 tows (range: 22-61; median: 36).

Throughout both survey time series, the largest and most consistent cod catches have been taken in sampling stratum 9 (southwest of Nantucket). Although only 8% (70/882) of the total spring tows accomplished in "cod strata" south of Georges Bank were performed in stratum 9, this stratum has accounted for 26% (228/1882) of the total number, and 20% of the (1207/6002) total

weight, of cod taken in all of the spring surveys (Tables 8-10). Similarly, in the autumn surveys, stratum 9 tows comprised only 16% of the total tows performed in Southern New England "cod strata", but yielded 51% (138/271) of the total number of cod captured and 52% (1008/1935) of the total weight of cod taken (Table 11).

Research Vessel Relative Abundance Indices

NEFC research vessel relative abundance survey indices for Southern New England-Middle Atlantic cod were calculated in terms of stratified mean catch per tow in numbers and weight, following procedures given by Cochran (1977: 91), viz.

$$\overline{Y}st = 1/N \sum_{h=1}^{\ell} (N_h \overline{Y}_h)$$

where $\overline{Y}st$ = stratified mean catch per tow

N_h = area of the hth stratum

N = total area of all strata within the set

$\overline{Y}h$ = mean catch per tow in the hth stratum

ℓ = number of strata in the strata set

Total stratified mean catch per tow indices (numbers and weight) for the spring (1968-1979) and autumn (1963-1978) bottom trawl surveys in Southern New England and the Middle Atlantic are given in Table 13.

The spring survey indices (both numbers and weight per tow) exhibit similar trends; calculated values declined between 1969-1972, increased markedly in 1973, and generally declined again from 1974-1977. In 1978 and 1979, the mean number per tow increased and then decreased, while the mean weight per tow decreased and subsequently increased. Since the spring surveys conducted during 1968-1972 used a "36 Yankee" trawl while those performed

annually thereafter a "41 Yankee" trawl, it is difficult to interpret the entire spring series of indices in a standardized fashion. Although the "41 Yankee" trawl possesses a larger surface area than the "36 Yankee" trawl, catch adjustments between gear have not been made since differences in cod catchability have not been statistically evaluated. Nonetheless, the observed annual declines in the spring indices during both 1968-1972 (using "36 Yankee" trawl) and 1974-1977 (using "41 Yankee" trawl) imply an overall reduction in Southern New England-Middle Atlantic cod populations from the late 1960's until 1978. Moreover, since most post-1973 spring indices are less then the values for 1968-1972, any conversion factor for standardizing the indices based on gear surface area differences between the trawls would effectively further lower the post-1973 indices relative to the earlier catch per tow results.

The 1978-1979 spring indices (Table 13) suggest some recent improvement in relative abundance of Southern New England-Middle Atlantic cod. The 1978 number-per-tow index (0.98) was the second highest value since 1973, and more than twice as large as either the 1976 or 1977 values. The 1979 weight-per-tow-index (4.32) was 7% larger than the 1978 value and approximated the mean weight per tow average for 1976-1978 (4.53).

The annual autumn Southern New England survey indices have exhibited greater fluctuations than the spring indices, although trends in the autumn values are consistent with those observed in the spring (Table 13). Highest autumn number-per-tow values occurred in 1967 and 1975 (1.45 and 0.96, respectively); highest autumn weight-per-tow indices occurred in 1963, 1967, and 1975 (8.98, 8.92, and 7.56, respectively). These peak values are over an order of magnitude larger than the corresponding lowest indices in the time-series (numbers: 0.08 in 1977; weight: 0.44 in 1971). No cod were caught in the autumn 1973 survey; an apparently anomalous condition since

the spring 1973 indices were the highest in that survey series, and both 1972 and 1974 spring and autumn indices reflected at least average relative abundance levels.

The autumn survey indices (numbers and weight) can be classified into three periods during which annual values declined and which subsequently were followed by a single year in which indices markedly increased: (1) 1963-1966 when relatively high indices declined to average historical levels (1963-1978: mean number per tow = 0.49 (median = 0.42); mean weight per tow = 3.56 (median = 2.27)), and then rose in 1967 to the highest levels observed; (2) 1969-1971 during which annual survey values successively decreased to the lowest observed (lowest weight; second lowest numbers) and then increased to very high levels in 1972; and (3) 1975-1977 when catch per tow values annually declined and subsequently increased in 1978. The observed increases in 1978, however, were much more modest than in 1967 or 1973. Although the 1978 autumn values were approximately double those of 1977, they were well below average historical levels. Hence, similar to the latest (1978-1979) spring survey indices, the 1978 autumn values indicate recent improvement in relative abundance; both current spring and autumn indices, however, are among the lower ones in the time series (Figure 8).

Stratified mean catch (numbers) per tow values of Atlantic cod in Southern New England and the Middle Atlantic derived from the NEFC spring and autumn (1970-1978) offshore bottom trawl surveys are given in Tables 14 and 15, respectively. Although considerable variation exists within each data set (particularly the autumn data due to low annual survey catches), both time series indicate a strong 1971 year class. In addition, the spring numbers at age indices (Table 14) and the associated yearly survey length-frequency

distribution (Figure 9) indicate that the 1966 year class was also very strong.

In more recent years (since 1973), trends in survey year class catch per tow values have not been as consistent or pronounced as previously. Both the 1974 and 1975 year classes appear to have been of average size or better (with the 1975 cohort the better of the two), though very much less than either the 1966 or 1971 year classes. The 1976 year class appears to have been relatively poor, while the 1977 cohort seems average in size. Single point estimates of the 1978 year class (age 0 cod) from the spring and autumn 1978 surveys suggest above average strength for this cohort. Since successive catch per tow values of the more recent year classes have often shown irregular fluctuation, qualitative evaluation of year class strength is accordingly somewhat imprecise.

Comparison of the relative dominance of year classes in the Southern New England-Middle Atlantic region with those from Georges Bank (Table 16) reveals generally similar trends in year class strength. Both the 1966 and 1971 year classes were the strongest cohorts observed in either region during the past 15 years. The 1975 year class, strong on Georges Bank, appears to be only better than average in the south, although slight differences in the proportional representation of the same year class between both regions are not uncommon (i.e., the 1966 and 1971 year classes appeared proportionally stronger in Southern New England-Middle Atlantic than on Georges Bank). Evaluation of relative year class strength for the 1976 year class (relatively poor) and the 1977 year class (average) is similar for both populations. Equally, the 1978 year class appears to be better than average in both groups based on age 0 survey catches (see Serchuk et al. 1979 for Georges Bank year class

strength appraisals). Hence, if the southerly cod populations are largely sustained by immigration of fish, the correspondence of recruitment patterns between Georges Bank and the Southern New England-Middle Atlantic suggests that this influx of individuals originates from Georges Bank. Since very few tagged Gulf of Maine cod have ever been recaptured west of Nantucket Shoals (Schroeder 1930, reported only five southern recaptures of about 16,000 fish tagged north of Cape Cod), emigration of Gulf of Maine fish into the southern region is likely of minor importance.

The similarities in Georges Bank and Southern New England-Middle Atlantic recruitment patterns may, alternatively, reflect similar reproductive responses in both of these cod groupings, rather than fish movement. This inference, however, presupposes that the southerly populations are self-sustaining, a questionable tenet based on survey catches of juvenile cod.

Total Mortality Estimates

Annual estimates of total instantaneous mortality rates (Z) for Southern New England-Middle Atlantic cod calculated from NEFC spring offshore catch (numbers) at age data, and pooled estimates for 1973-1978 are provided in Table 17.

The annual Z values range from 0.33-0.63 (age 3+) and 0.28-0.83 (age 4+), with no clear trend evident. Two estimates are provided since cod tend to recruit fully to the survey gear at age 3 but, due to the relative geographic absence of snapper and scrod cod in most years (1973 and 1977 were exceptions, however; see COMMERCIAL CATCH COMPOSITION), the commercial trawl fishery generally exploits "market-sized" fish (age 4+) and larger. Pooled total mortality estimates for 1973-1978 (earlier years could not be included because of survey gear differences) were 0.45 (age 3+) and 0.62 (age 4+). Assuming

an instantaneous natural mortality rate (M) of 0.2 for cod (Pinhorn 1972), a recent instantaneous fishing mortality rate (F) of 0.42 is implied, a rate slightly higher than the current conditional F_{max} = 0.32 (see YIELD PER RECRUIT).

Growth

Mean lengths at age calculated from NEFC spring offshore bottom trawl survey data, 1970-1978, indicate no salient changes in the growth rate of Southern New England-Middle Atlantic cod in recent years (Table 18). The greatest fluctuations in mean size at age occur in the youngest and oldest age groups where annual survey sample sizes are generally small. Mean lengths of age 4 and 5 cod tend to have increased during 1975-1978 from 1970-1971 but these differences are generally not statistically significant (note standard deviations).

The growth rate of Southern New England-Middle Atlantic cod corresponds closely to that of Georges Bank fish (Table 19). Only minor nonsystematic differences in lengths for age groups 0-6 are evident between the two cod populations. Comparison of mean lengths at age for older age groups is difficult because of the lack of adequate numbers of fish in the southern survey catches. No cod older than age 11 have ever been taken in the Southern New England-Middle Atlantic surveys, while cod as old as ages 14 and 17 have been taken on Georges Bank in the autumn and spring surveys, respectively.

A von Bertalanffy growth equation for the Southern New England-Middle Atlantic cod populations was calculated using Allen's method (1966) to the pooled (1970-1978) spring mean length at age data derived from 461 age samples expanded to the entire spring survey catches (669 fish, including some fish from inshore surveys). Ages were coded relative to survey scheduling by

assuming a January 1 birth date, e.g., an age 1 cod was assumed to be 1.3 years old when caught during the spring survey (April). Mean length at age data for age 0 fish and age groups 10 and 11 were excluded from the growth analysis due to the low number of age samples available (4, 4, and 2, respectively). The resultant population parameters of the von Bertalanffy equation, together with their standard deviations and 0.05 confidence limits, are:

Southern New England-Middle Atlantic cod			
Parameter	Value	Standard deviation	Confidence limits (0.05)
K	0.257	0.012	± 0.029
L_∞(cm)	112.937	1.820	± 4.453
t_o	0.465	0.055	± 0.135

Predicted lengths at age agree well with both individual survey mean lengths at age (Table 18) and the pooled data (Table 20; r = 0.999). The calculated L_∞ value of 113 cm appears to be an accurate estimate of the average maximum length attainable since only three cod have ever been taken in either the spring or autumn offshore surveys (1963-1979) that were larger in size (116, 119, and 122 cm);none larger than 113 cm have been taken since 1974. This contrasts with Georges Bank and Gulf of Maine cod where fish as large as 149 cm and 146 cm, respectively, have been recorded in survey catches. For these latter groups, Penttila and Gifford (1976) estimated L_∞ values of 148.1 cm (Georges Bank) and 146.5 cm (Gulf of Maine) from NEFC offshore survey data obtained during 1970-1974.

If the Southern New England-Middle Atlantic cod populations depend, in part, on immigration of fish from the north, the present results suggest that very large cod do not regularly migrate into the southerly region or that such fish are either harvested rapidly or are unavailable to trawl gear.

Yield Per Recruit

Yield isopleths for Southern New England-Middle Atlantic cod were calculated using the allometric growth model of Paulik and Gales (1964) assuming W_∞ = 14.92 kg, K = 0.257, t_o = 0.465 years, t_r = 1.0 year, t_λ = 12 years, and M = 0.2 (Figure 10). Transverse yield per recruit curves were also calculated for t_c (age at first capture) values of 2.55, 2.77, and 3.00 years; these ages correspond to the mean 50% retention lengths (L_c) that would be obtained using cod-end stretched mesh sizes of 130 mm (5 1/8": presently required minimum mesh size), 140 mm (5½": proposed minimum mesh size for Georges Bank and the Gulf of Maine), and 150 mm, respectively, assuming an average polyamide fiber cod selection factor of 3.6 (Holden 1971; Smolowitz 1979) (Figure 11).

Unconditional maximum yield per recruit (F_{max}) occurs at an optimum age of exploitation (t_y: Beverton and Holt 1957) of 6.67 years (using estimation procedures of Krishnan Kutty and Qasim 1968) and an instantaneous fishing mortality of F = 9.8. Conditional values of F_{max}, related to 130, 140, and 150 mm minimum mesh sizes, are 0.32, 0.36, and 0.39, respectively; corresponding $F_{0.1}$ (Gulland 1977) values are 0.21, 0.23, and 0.24 (Figure 11). Assuming a January 1 birthdate, t_c would occur for each of the three mesh sizes in July, September, and January, respectively.

Marginal yield per recruit at F levels above $F_{0.1}$ is relatively minor; approximately 95% of maximum yield per recruit is achieved at $F_{0.1}$ for any of the three mesh sizes (Figure 11). If fishing mortality was reduced from F = 0.42 (estimated F for 1973-1978: see TOTAL MORTALITY ESTIMATES) to F = 0.21

($F_{0.1}$ for 130 mm mesh), yield per recruit would only be reduced by 4.3%.

Yield per recruit curves for Southern New England-Middle Atlantic cod are similar to those derived for the Georges Bank cod populations (Serchuk et al. 1979: 130 mm mesh, $F_{max} = 0.3$, $F_{0.1} = 0.15$). Accordingly, the effects of changes in t_c (via mesh size) and F on yield per recruit in both cod groups should result in nearly identical yield responses.

Commercial Fishery

Distribution of USA Landings by Gear

In recent years, the USA commercial cod fishery in Southern New England has accounted for 74% of the total domestic cod landings south of Georges Bank (Table 2) and has been prosecuted primarily by otter trawling. Annual distributions of Southern New England cod landings, by gear, during 1968-1978 (Table 21) indicate that in most years otter trawls have taken greater than 95% of the reported catch. Over the period, otter trawlers have accounted for 93.2% of the total areal cod landings, with other gear types (line trawl; hand line) contributing very little.

Seasonal Trends in Landings

Monthly summaries of Southern New England USA otter trawl landings of cod, 1968-1978, show a distinct seasonal exploitation pattern (Table 22). Peak landings occur from December through April; 82.2% of the total cod otter trawl catches has been taken in these months. For directed cod trips (i.e., trips in which cod comprised 50% or more of the total trip landed weight), 91.6% of the cod landings from Southern New England occurred during these five months (Table 23). Both total and directed catches decline precipitously during late spring and remain at low levels until late autumn when they sharply increase. These patterns reflect the geographical and

seasonal movements of the southerly cod populations as evinced by tagging studies and research survey catch location data.

USA Commercial Effort and Catch

Effort statistics (days fished; number of trips) for the Southern New England USA otter trawl fishery for cod, derived from NMFS dockside commercial fishermen interviews and trip landings records, 1968-1978, were examined for recent trends in annual fishing effort. Individual trip records were grouped, within years, by vessel tonnage class (Class 2: 0-50 GRT; Class 3: 51-150 GRT; Class 4: 151-500 GRT). Both total effort (days fished and number of trips for otter trawl vessels landing any cod from Southern New England), and directed effort (trips and days fished during those trips in which cod comprised 50% or more of the total trip catch weight) were analyzed for temporal patterns (Tables 24 and 25).

Between 1968 and 1971, Class 2 vessels dominated the fishery accounting for 58% of the total days fished, 81% of the total trips, and 64% of the otter trawl catch (Tables 24, 25, and 26). During 1972-1974, tonnage class 3 vessels fished more days than those in the smaller class (2165 vs 2019: 52% and 48% of the total effort, respectively) and accounted for 53% of the cod catch. For both tonnage groups, the number of days spent fishing per trip was substantially higher in this time period than in the earlier four year period (Class 2: 0.55 vs 0.34; Class 3: 1.25 vs 1.05). In 1975 and 1976, total effort (trips and days fished) by both vessel classes sequentially declined resulting in Class 2 vessels again dominating the fishery. During this interval, the smaller vessels accounted for 54% of the total days fished, 53% of the total trips, and 69% of the catch. Since 1977, however, vessels in tonnage class 3 have reassumed dominance in the fishery by taking 71% of the catch while expending 59% of the total days fished and 45% of the total trips.

In the decade, 1968-1977, total catch and effort of class 2 vessels landing cod from Southern New England tended to decrease annually. Comparing the 1968 and 1977 statistics, total catch decreased 69% (677 vs 207 mt), total days fished decreased 53% (964 vs 454), and total trips decreased 72% (3000 vs 826). For class 3 vessels, total catch and effort of otter trawlers catching cod tended twice in the 10-year period to alternately and successively decrease and increase. Comparison of the 1968 and 1977 data shows a 82% increase in cod catch (288 to 525 mt), an 11% decrease in days fished (638 to 566), and a 33% increase in the total number of trips (470 vs 626). Participation of class 4 vessels in the fishery has been negligible throughout the period, accounting for 1% or less of the total cod catch or effort.

Until 1977, cod in Southern New England were generally taken as by-catch in the mixed trawl fishery. Between 1968 and 1976, the annual percentage of the total trawl landings representing directed effort varied between 18.6% (1969) and 43.4% (1974), and averaged 26% of the total trawl cod catch (Table 26). Class 2 vessels dominated the low level directed fishery in these years accounting for 63% of the total directed days fished, 81% of the total directed trips, and 59% of the total directed cod landed.

Beginning in 1977, directed trips have accounted for more than half of the total weight of cod landed from Southern New England (51.6% in 1977; 57% in 1978; Table 26). Both days fished and the number of trips by class 2 and 3 vessels in the directed fishery sharply increased in the past two years (Tables 24 and 25) resulting in directed effort in 1978 accounting for 18.6% of the total days fished and 12.9% of the total trips. Hence, for 1978, over half the total trawl cod landings were attributable to less than 20% of the total effort. Class 3 vessels have displaced the class 2 vessels in fishery

prominence; in 1978, this larger vessel class accounted for 64% of the directed catch (538/841 mt) and 71% of the total cod catch (1046/1476 mt) from the Southern New England trawl landings.

The recent apparent shift in the importance of cod from a secondary to a primary species in Southern New England coincided with the implementation of domestic management regulations in the groundfish fishery under the Fishery Conservation and Management Act (see MANAGEMENT UNDER FCMA). As part of these regulations, restrictions were enacted in the yellowtail flounder fishery in Southern New England (W. of 69° longitude) encompassing prohibition of directed fishing, vessel trip catch limits, annual quotas, and complete fishery closures. Since the yellowtail flounder fishery has traditionally been of much greater importance in terms of landed weight and value than cod in Southern New England, these restrictions probably resulted in a displacement of yellowtail flounder effort towards cod. Moreover, since yellowtail flounder trip limits tended to be lower than those for Georges Bank and South cod, vessels in the mixed trawl fishery would, by taking the permissable cod and yellowtail trip limits, generally land more cod per trip than previously. In some instances, vessels would first direct their effort to take the yellowtail trip limit, and subsequently fish for the relatively more abundant cod; the economic rationale for this practice was the large price per pound differential between the two species. In either case, the result of these changes in fishing patterns would be that cod often comprised greater than 50% of a vessel trip catch. Accordingly, the directed cod fishery (using the 50% criterion) in Southern New England has appeared more important in the past two years than formerly.

USA Commercial Catch Per Effort

Annual commercial indices of catch per unit of effort (metric tons of cod landed per day fished), 1968-1978, were derived for vessel tonnage classes 2 and 3 otter trawlers from 1,566 individual Southern New England trip records. Only individual vessel trips conducted during December-April and in which the cod catch formed $\geq$ 50% of the total were included in the analysis. Since the Southern New England cod fishery is highly seasonal (see SEASONAL TRENDS IN LANDINGS), the derived directed catch per effort indices encompassed 98% of the total class 2 directed cod trips (1169/1189) and 97% of the total directed class 3 cod trips (397/410). The reported effort was actual fishing time with the net on the bottom recorded to the nearest tenth of a day.

The annual catch per effort indices of both vessel classes exhibited similar trends between 1968 and 1977 (Table 27). Annual values steadily declined from 1968-1972 (about a 50% reduction in both classes), increased in 1973, declined steadily again until 1976 (about a 40% reduction in both classes) and then sharply increased in 1977 (Figure 12). In 1978, annual class 2 catch per effort further increased while the class 3 index declined. This disparity is probably reflective of restrictive management measures (trip limits in effect during the year) rather than actual fishing performance.

The observed trends in annual commercial catch per effort are similar to those in stratified mean catch per tow of cod from the spring offshore bottom trawl surveys in Southern New England and the Middle Atlantic during 1968-1978 (Table 13), particularly the number per tow indices. In both time series, annual values decreased (1968-1972; 1974-1976) and increased (1973, 1977-1978) in almost parallel fashion. The correspondence between the commercial indices and spring survey weight per tow values is also striking, although the survey indices for 1977 and 1978 trend downward rather than up.

Commercial Catch Composition

Distribution of annual USA commercial landings of Atlantic cod from Southern New England and the Middle Atlantic, by market category, during 1964-1978 indicates that "market cod" (2.5-10.0 lbs; 1.1-4.5 kg) have generally comprised greater than 50% of the annual catch by weight (Table 28). The annual percentage of "scrod cod" (1.5-2.5 lbs; 0.7-1.1 kg) in the yearly landings has tended to be less then 20%; major exceptions occurred in 1973 and 1977 when scrod landings accounted for 47% and 46%, respectively, of the total catch. Since Southern New England-Middle Atlantic cod first become recruited to the commercial fishery as "scrod" at age 2 (similar to Georges Bank fish), the large proportional representation of "scrod" in 1973 and 1977 are indicative of strong 1971 and 1975 year classes. Hence, these data corroborate the offshore bottom trawl survey catch-at-age findings (Tables 14 and 15) and the survey length-frequency results (Figure 9) which showed these year classes to be strong.

The relative market category composition of the commercial Southern New England-Middle Atlantic cod landings closely resembles that from Georges Bank (Serchuk et al. 1979: Table 3) for almost all years. Yearly changes in each of the market categories tend to occur in parallel fashion in both data sets. The proportional increases or decreases in market category percentages in both areas between adjacent years are, in fact, often virtually identical (i.e., 1964-65: large and market categories; 1973-74: market and scrod categories).

Discussion

Current evaluations of the Southern New England-Middle Atlantic cod populations (those southwest of Georges Bank) have been based on research vessel survey results and patterns in commercial catch, catch per effort, and catch composition. Both sets of data reveal similar trends in seasonal and geographic population distribution, relative abundance, and recruitment. Equally, close correspondence between Southern New England-Middle Atlantic results and Georges Bank results from both survey and commercial data is evident. All data sets are consistent in indicating increases in abundance associated with strong recruitment of the 1971 and 1975 year classes. The appearance of this latter year class in the population was propitious since spring survey indicies (numbers and weight per tow) and commercial catch per effort values during 1974-1976 generally declined; the 1976 values for both data sets were among the lowest in their respective time series implying a relatively low level of population abundance. More recent values indicate an improvement and stabilization in biomass levels.

Total commercial annual landings (USA and foreign) of cod from Southern New England and the Middle Atlantic during 1968-1974 averaged 2,456 metric tons per year, approximately equal to the long-term (1929-1978) mean yearly commercial catch (2,360 metric tons). During 1975 and 1976, total commercial cod harvests successively declined each year by about 50% (1975: 1451 mt; 1976: 742 mt) presumably as a result of decreases in cod abundance and reductions in foreign effort. The USA commercial catch in 1978 (no foreign landings permitted under FCMA) was approximately double that of 1977, amounting to a total of 1,962 metric tons.

Recreational catches of cod by the New York and New Jersey party boat industry have approached only incidental levels since 1975 (Nicholson and Ruais 1979). Prior to 1975, however, cod was the principal species sought in the winter Middle Atlantic party boat fishery. Thus, recreational trends in landings appear similar to those from the commercial fishery. The strong 1975 year class which dominated commercial catches in 1977 and 1978 may hence be important in the winter recreational fishery beginning in late 1979.

Total fishing mortality during 1973-1978 was slightly above F_{max}. Recent mesh size increases in the commercial trawl fishery should prove beneficial in increasing yield per recruit.

The stock integrity of the Southern New England-Middle Atlantic cod populations remains unresolved. Circumstantial evidence from growth analyses, research survey catch composition and relative abundance indices, and commercial catch composition, however, suggest strong affinities with the Georges Bank cod stock. The relative absence of juvenile cod in either the inshore or offshore time series of survey catches in the Southern New England-Middle Atlantic region implies that either the southerly populations are not self-sustaining or that offspring from the southern spawning move north as ichthyoplankton or larval nekton and subsequently return several years later as adults.

The question of biological stock identity of the southerly cod populations may be moot relative to management concerns. If the similarities between the Southern New England-Middle Atlantic and Georges Bank cod populations result from similar biotic and environmental factors, management measures applied to the two groupings as a unit should produce similar responses within each group. Contrariwise, if the similarities between the groups reflect the movement of Georges Bank fish southward, then only one biological stock exists and management measures applied similarly in both regions should produce a uniform impact.

Literature Cited

Allen, K. R. 1966. A method of fitting growth curves of the von Bertalanffy type to observed data. J. Fish. Res. Board Can. 23:163-179.

Berrien, P. L., M. P. Fahay, A. W. Kendall, Jr., and W. G. Smith. 1978. Ichthyoplankton from the RV Dolphin survey of continental shelf waters between Martha's Vineyard, Massachusetts, and Cape Lookout, North Carolina, 1965-66. Technical Series Report No. 15, Sandy Hook Laboratory, Northeast Fisheries Center, NMFS, Highlands, New Jersey.

Beverton, R. J. H., and S. J. Holt. 1957. On the dynamics of exploited fish populations. Fishery Invest., Lond. Ser. 2, 19:1-533.

Brown, B. E. 1971. A preliminary review of the status of the Subarea 5 cod stock. Int. Comm. Northw. Atlant. Fish., Res. Doc. 71/125, Serial No. 2623 (mimeo), 14 p.

Brown, B. E., and E. G. Heyerdahl. 1972. An assessment of the Georges Bank cod stock (Div. 5Z). Int. Comm. Northw. Atlant. Fish., Res. Doc. 72/117, Serial No. 2831 (mimeo), 24 p.

Clark, A. H. 1887a. The fisheries of Massachusetts. In Goode, G. B., The Fisheries and Fishery Industries of the United States, Section II, A Geographical Review of the Fisheries Industries and Fishing Communities for the year 1880, Washington, DC, p. 113-280.

Clark, A. H. 1887b. The fisheries of Rhode Island. In Goode, G. B., The Fisheries and Fishery Industries of the United States, Section II. A Geographical Review of the Fisheries Industries and Fishing Communities for the year 1880, Washington, DC, p. 281-310.

Clark, A. H. 1887c. The coast of Connecticut and its fisheries. In Goode, G. B., The Fisheries and Fishery Industries of the United States, Section II, A Geographical Review of the Fisheries Industries and Fishing Communities for the year 1880, Washington, DC, p. 311-340.

Clark, J. R. 1962. The 1960 salt-water angling survey. U.S. Dept. Interior, Bur. Sport Fish. Wildl. Circ. 153, 36 p.

Clark, S. H. 1979. Application of bottom trawl survey data to fish stock assessment. Fisheries 4(3):9-15.

Clark, S. H., and B. E. Brown. 1977. Changes in biomass of finfishes and squids from the Gulf of Maine to Cape Hatteras, 1963-74, as determined from research vessel survey data. Fish. Bull., U.S. 75:1-21.

Cochran, W. G. 1977. Sampling Techniques (3rd Ed.), John Wiley and Sons, New York, 428 p.

Collins, J. W., and R. Rathbun. 1887. The sea fishing grounds of the eastern coast of North America from Greenland to Mexico. In Goode, G. B., The Fisheries and Fishery Industries of the United States, Section III, The Fishing Grounds of North America, Washington, DC, p. 5-78.

Deuel, D. G. 1973. The 1970 salt-water angling survey. NOAA, Nat. Mar. Fish. Serv., Current Fish. Stat. No. 6200, 54 p.

Deuel, D. G., and J. R. Clark. 1968. The 1965 salt-water angling survey. U.S. Fish Wildl. Serv., Resource Publ. No. 67, 51 p.

Earll, R. E. 1887. New Jersey and its Fisheries. In Goode, G. B., The Fisheries and Fishery Industries of the United States, Section II, A Geographical Review of the Fisheries Industries and Fishing Communities for the year 1880, Washington, DC, p. 379-400.

Goode, G. B. 1884. The cod-Gadus morhua. In Goode, G. B. The Fisheries and Fishery Industries of the United States, Section I, Natural History of Useful Aquatic Animals, Part III, Fishes, Washington, DC, p. 200-223.

Goode, G. B. 1887. American Fishes. Estes and Lauriat, Boston, 496 p.

Graham, H. W. 1952. Mesh regulation to increase the yield of the Georges Bank haddock fishery. In Int. Comm. Northw. Atlant. Fish., Second Ann. Rept. 1951-1952, p. 23-33.

Graham, H. W., and E. D. Premetz. 1955. First year of mesh regulation in the Georges Bank haddock fishery. U.S. Fish Wildl. Serv., Spec. Sci. Rept.-Fish. No. 142, 29 p.

Grosslein, M. D. 1969. Groundfish survey program of BCF Woods Hole. Comm. Fish. Rev. 31(8-9):22-35.

Grosslein, M. D. 1974. Bottom trawl survey methods of the Northeast Fisheries Center, Woods Hole, Mass., USA. Int. Comm. Northw. Atlant. Fish., Res. Doc. 74/96, Serial No. 3332 (mimeo), 27 p.

Gulland, J. A. 1977. Goals and objectives of fishery management. FAO Fisheries Technical Paper No. 166, 14 p.

Gusey, W. F. 1976. The Fish and Wildlife Resources of the Middle Atlantic Bight. Shell Oil Company, Houston, Texas, 581 p.

Hardy, J. D. Jr. 1978. Gadus morhua Linnaeus, Atlantic cod. In Development of Fishes of the Mid-Atlantic Bight, Volume II, Anguillidae through Syngnathidae, Biological Services Program, U.S. Fish Wildl. Serv., p. 236-259.

Hildebrand, S. F., and W. C. Schroeder. 1928. Fishes of Chesapeake Bay. Bull. U.S. Bur. Fish. 53 (Part I):1-388.

Holden, M. J. 1971. Report of the ICES/ICNAF Working Groups on Selectivity Analysis. ICES Coop. Res. Rept. No. 25, 144 p.

International Commission for the Northwest Atlantic Fisheries. 1968. Redbook, Part I, Report of the Standing Committee on Research and Statistics, Appendix I - Assessments, Annex IV, p. 57-59.

International Commission for the Northwest Atlantic Fisheries. 1969. Redbook, Part I, Report of the Standing Committee on Research and Statistics, Appendix I - Assessments, p. 34.

Jensen, A. C. 1974a. Sport fisheries and offshore oil. N.Y. Fish and Game Jour. 21:105-116.

Jensen, A. C. 1974b. Sport fishing for cod. N.Y.S. Conservationist 28(6): 15-19.

Jensen, A. C. 1976. Offshore oil and fishery resources. N.Y. Fish and Game Jour. 23:138-148.

Jensen, A. C. 1977. New York's marine fisheries: changing needs in a changing environment. N.Y. Fish and Game Jour. 24:99-128.

Jensen, A. C., and R. K. Brigham. 1973. The line-trawl fishery for cod and haddock at Chatham, Massachusetts. Comm. Fish. Rev. 25(6):14-19.

Jensen, A. C., and H. E. Murray. 1965. The U.S. cod fishery in the Northwest Atlantic. Comm. Fish. Rev. 27(7):1-11.

June, F. C., and J. W. Reintjes. 1957. Survey of the ocean fisheries off Delaware Bay. U.S. Fish Wildl. Serv., Spec. Sci. Rept.-Fish. No. 222, 55 p.

Krishnan Kutty, M., and S. Z. Qasim. 1968. The estimation of optimum age of exploitation and potential yield in fish populations. J. Cons. perm. int. Explor. Mer 32:249-255.

Leim, A. H., and W. B. Scott. 1966. Fishes of the Atlantic Coast of Canada. Fish. Res. Board Can. Bull. No. 155, 485 p.

Lyles, C. H. 1967. Historical catch statistics, cod, 1879-1965. In Fishery Statistics of the United States, 1969. Stat. Digest 59, Bur. Comm. Fish., U.S. Fish Wildl. Serv., Washington, DC, p. 131 and 207.

Mather, F. 1887. New York and its fisheries. In Goode, G. B., The Fisheries and Fishery Industries of the United States, Section II. A Geographical Review of the Fisheries Industries and Fishing Communities for the year 1880, Washington, DC, 341-377.

McConnell, K. E., and T. P. Smith. 1979a. Marine recreational fishing in Rhode Island, February and March, 1978. NOAA/Sea Grant, Univ. Rhode Island Marine Memorandum 55, 10 p.

McConnell, K. E., and T. P. Smith. 1979b. Marine recreational fishing in Rhode Island, April and May, 1978. NOAA/Sea Grant, Univ. Rhode Island Marine Memorandum 56, 15 p.

McHugh, J. L. 1972. Marine Fisheries of New York State. Fish. Bull., U.S. 70:585-610.

McHugh, J. L. 1977. Fisheries and fishery resources of New York Bight. U.S. Dept. Comm., NOAA Tech. Rept., NMFS Circ. 401, 50 p.

McHugh, J. L. 1978. Historic fish and shellfish landings and trends. In McHugh, J. L., and J. J. C. Ginter (eds), Fisheries, MESA New York Bight Atlas Monograph No. 16, New York Sea Grant Institute, Albany, NY, p. 6-80.

McHugh, J. L., and J. J. C. Ginter. 1978. Fisheries. MESA New York Bight Atlas Monograph No. 16, New York Sea Grant Institute, Albany, NY, 129 p.

McHugh, J. L., and A. D. Williams. 1976. Historical statistics of the fisheries of the New York Bight area. New York Sea Grant Institute, Albany, NY, 73 p.

Mohn, P. T. 1976. Marine sport fisheries of New York State. M.S. Thesis, State Univ. N.Y. at Stony Brook, 120 p.

Nichols, J. T., and C. M. Breder, Jr. 1927. The marine fishes of New York and Southern New England. Zoologica 9:1-192.

Nicholson, L. E., and R. P. Ruais. 1979. Description of the recreational fisheries for cod, haddock, pollock, and silver hake off the northeast coast of the U.S. Report to the New England Regional Fishery Management Council, April 1, 1979, 118 p.

North American Council on Fishery Investigations. 1932. Proceedings for 1921-1930, No. 1, 56 p.

North American Council on Fishery Investigations. 1935. Proceedings for 1931-1933, No. 2, 40 p.

Paulik, G. J., and L. E. Gales. 1964. Allometric growth and the Beverton-Holt yield equation. Trans. Amer. Fish. Soc. 93:369-381.

Pearson, J. C. 1932. Winter trawl fishery off the Virginia and North Carolina coasts. U.S. Bur. Fish., Invest. Rep. No. 10, 31 p.

Pearson, J. C. 1972. The Fish and Fisheries of Colonial North America. Parts III and IV, The Middle Atlantic States and The Chesapeake Bay States. National Technical Information Service, Springfield, Virginia, p. 679-990.

Penttila, J. A., and V. M. Gifford. 1976. Growth and mortality rates of cod from the Georges Bank and Gulf of Maine areas. Int. Comm. Northw. Atlant. Fish., Res. Bull. 12:29-36.

Pierce, D. E., and P. E. Hughes. 1979. Insight into the methodology and logic behind National Marine Fisheries Service fish stock assessments or How did you guys come up with those numbers anyway? Massachusetts Office of Coastal Zone Management, Boston, Mass., 17 p.

Pileggi, J., and B. G. Thompson. 1979. Fisheries of the United States, 1978. NOAA, NMFS, Current Fishery Statistics No. 7800, 120 p.

Pinhorn, A. T. 1972. Estimates of natural mortality for ICNAF Division 2J cod. Int. Comm. Northw. Atlant. Fish., Res. Doc. 72/2, Serial No. 2681 (mimeo), 7 p.

Power, E. A. 1960. United States Atlantic Cod Fishery, 1893-1958. In Fishery Statistics of the United States, 1958. Stat. Digest 49, Bur. Comm. Fish., U.S. Fish Wildl. Serv., Washington, DC, p. 385-387.

Power, E. A. 1968. Highlights in the collection, tabulation, and publication of fishery statistics, 1880-1967. Manuscript report (unpublished). Div. Economics, U.S. Bur. Comm. Fish., 94 p.

Ridgely, J. E., and D. G. Deuel. 1975. Participation in marine recreational fishing, northeastern United States, 1973-74. U.S. Dept. Commerce, NMFS, Comm. Fish. Stat. No. 6236, 7 p.

Schroeder, W. C. 1930. Migrations and other phases in the life history of the cod off Southern New England. Bull. U.S. Bur. Fish., 46:1-136.

Serchuk, F. M., P. W. Wood, and B. E. Brown. 1978. Summary and review of the 1978 assessment and status of the Georges Bank and Gulf of Maine cod stocks. Nat. Mar. Fish. Serv., Woods Hole Lab. Ref. No. 78-11, 18 p.

Serchuk, F. M., P. W. Wood, R. Lewis, J. A. Penttila, and B. E. Brown. 1979. Status of the Georges Bank and Gulf of Maine cod stocks, February 1979. Nat. Mar. Fish. Serv., Woods Hole Lab. Ref. No. 79-10, 32 p.

Sherman, K., and J. P. Wise. 1961. Incidence of the cod parasite Lernaeocarca branchialis L. in the New England area, and its possible use as an indicator of cod populations. Limnol. Oceanogr. 6:61-67.

Smith, H. M. 1902. Notes on tagging of 4,000 adult cod at Woods Hole, Mass. Rep. U.S. Fish. Comm. 27:193-208.

Smith, H. M. 1907. The Fishes of North Carolina. North Carolina Geological and Economic Survey, Vol. II, Raleigh, NC, 453 p.

Smolowitz, R. J. 1979. Mesh size and New England groundfish. Nat. Mar. Fish. Serv., Woods Hole Lab. Ref. No. 79-02, 71 p.

Wise, J. P. 1958. The world's southernmost indigenous cod. J. Cons. perm. int. Explor. Mer 23:208-212.

Wise, J. P. 1962. Cod groups in the New England areas. Fish. Bull., U.S. 63:189-203.

Table 1. USA commercial landings (metric tons, live) of Atlantic cod, by state, 1880-1978.

Year	State											Totals	
	Maine	New Hamp.	Mass.	Rhode Island	Conn.	New York	New Jersey	Penn.	Delaware	Maryland	Virginia	Maine to Virginia	R.I. to Virginia
1880	25,403	2,471	(1)	1,172	1,242	1,624	756	(1)	(1)			32,668	4,794
1887	20,421	978	71,520	168	1,016	1,567	357	14	(1)			96,041	3,122
1888	18,258	681	69,022	163	908	1,449	329	10	(1)			90,820	2,859
1889	13,162	712	59,683	195	694	853	445	67	(1)			75,811	2,254
1890	(1)	(1)	(1)	(1)	(1)	880	331	64	(1)			1,275	1,275
1891	(1)	(1)	(1)	(1)	(1)	1,033	381	60	(1)			1,474	1,474
1897	5,210	222	47,920	(1)	(1)	960	1,579	-	-			55,891	2,539
1898	9,324	314	46,266	790	205	(1)	(1)	(1)	(1)			56,899	995
1901	(1)	(1)	(1)	(1)	(1)	532	1,044	-	-			1,576	1,576
1902	10,831	200	44,627	313	96	(1)	(1)	(1)	(1)			56,067	409
1904	(1)	(1)	(1)	(1)	(1)	531	572	-	-			1,103	1,103
1905	5,562	155	36,078	498	252	(1)	(1)	(1)	(1)			42,545	750
1908	9,078	61	33,030	679	372	1,360	1,709	23	3			46,315	4,146
1919	6,832	44	32,964	521	44	(1)	(1)	(1)	(1)			40,405	565
1921	(1)	(1)	(1)	(1)	(1)	303	312	-	-			615	615
1924	10,180	44	31,305	616	244	(1)	(1)	(1)	(1)			42,389	360
1926	(1)	(1)	(1)	(1)	(1)	1,199	1,006	6	-			2,211	2,211
1928	7,342	11	30,693	1,024	1,906	(1)	(1)	(1)	(1)			40,976	2,930
1929	8,011	2	29,096	1,139	1,214	1,308	2,720		7	-	25	43,522	6,413
1930	6,116	72	35,164	704	4,044	1,281	3,529		44	-	23	50,977	9,625
1931	5,739	27	33,239	411	2,553	665	2,822		23	-	19	45,498	6,493
1932	5,491	25	32,423	327	868	1,514	1,867		13	-	10	42,538	4,599
1933	4,235	13	40,465	412	67	1,933	1,465		1	-	3	48,594	3,881
1935	3,813	6	50,183	276	304	471	371		-	-	-	55,424	1,442
1937	3,198	-	57,302	484	72	1,725	1,163		22	22	-	63,988	3,488
1938	2,822	-	50,492	334	51	3,373	1,022		26	-	-	58,620	5,306
1939	1,509	11	46,048	233	15	2,785	759		15	-	2	51,377	3,809
1940	1,446	9	35,634	211	25	1,232	403		15	1	2	38,979	1,890
1942	2,241	16	26,931	301	37	1,322	703		9	-	-	31,560	2,372
1943	2,867	37	26,403	320	102	1,184	368		1	-	-	31,782	2,475
1944	2,528	18	39,447	411	124	1,044	558		8	19	4	44,161	2,168
1945	3,141	15	60,219	507	108	792	1,085		17	52	1	65,937	2,562
1946	3,354	(1)	36,447	355	86	1,444	(1)		(1)	40	7	41,733	1,932
1947	2,084	3	26,545	306	110	630	641		1	10	6	30,336	1,704
1948	2,897	4	27,556	358	144	791	581		2	26	5	32,364	1,907
1949	2,756	1	22,370	774	268	1,069	629		-	15	1	28,383	2,756
1950	3,000	2	20,806	557	116	1,147	448		-	1	1	26,078	2,270
1951	2,401	5	18,466	527	137	880	272		-	-	1	22,689	1,817
1952	2,093	7	16,750	305	77	442	139		-	-	1	19,814	964
1953	1,710	-	12,458	275	26	330	15		-	-	-	14,814	646
1954	1,673	-	13,604	599	108	586	129		-	3	-	16,703	1,426
1955	1,299	-	12,939	360	84	1,024	423		-	10	-	16,139	1,901
1956	1,246	-	13,212	332	70	601	472		-	-	-	15,933	1,475
1957	1,067	-	12,878	381	150	781	196		-	1	-	15,454	1,509
1958	1,241	-	15,238	566	95	998	572		-	24	29	18,763	2,284
1959	1,222	-	16,591	565	110	886	1,489		2	174	45	21,084	3,271
1960	1,314	9	14,182	373	113	453	1,612		9	247	4	18,316	2,311
1961	1,137	14	17,312	484	181	629	1,091		15	358	14	21,135	2,672
1962	1,025	23	18,437	317	132	466	673		17	170	18	21,278	1,793
1963	839	34	16,883	231	62	400	502		40	68	23	19,132	1,326
1964	1,089	27	15,786	201	67	234	128		24	6	13	17,575	673
1965	1,193	39	14,603	198	55	166	75		22	-	1	16,352	517
1966	1,271	33	15,203	330	77	112	7		7	1	2	17,043	536
1967	1,586	32	17,542	600	139	207	24		-	10	-	20,140	980
1968	2,285	49	18,669	875	166	165	78		15	21	1	22,324	1,321
1969	2,094	70	22,326	1,121	194	204	56		1	6	10	26,082	1,592
1970	2,462	86	19,850	1,375	110	171	85		-	3	-	24,142	1,744
1971	1,986	91	21,117	1,047	82	194	63		5	2	-	24,587	1,393
1972	2,010	115	17,793	1,087	16	107	20		-	3	-	21,151	1,233
1973	1,830	214	19,238	1,350	48	151	39		-	1	-	22,871	1,589
1974	1,816	274	22,669	1,472	10	210	153		-	3	-	26,607	1,848
1975	2,538	(1)	21,040	856	(1)	195	140		(1)	7	-	24,776	1,198
1976	2,888	(1)	20,881	614	(1)	311	41		(1)	4	-	24,739	970
1977	4,140	(1)	27,360	1,556	(1)	264	21		(1)	-	-	33,341	1,841
1978	4,902	(1)	30,563	2,121	(1)	209	14		(1)	-	-	37,809	2,344

(1) Not available

SOURCE: Lyles (1967); Fishery Statistics of the United States, 1966-1974; Maine landings, 1975-1978; Massachusetts landings 1975-1978; Rhode Island landings 1975-1978; New York landings 1975-1978; Maryland landings 1975-1978; Virginia landings 1975-1978.

Table 2. Commercial landings (metric tons, live) of Atlantic cod from Southern New England (Subdivision 5Zw) and the Middle Atlantic (Statistical Area 6), by country, 1966-1978.

Year	USA			USSR			Poland			Other			Grand total		
	5Zw	6	Total	5Zw	6	Total	5Zw	6	Total	5Zw	6	Total	5Zw	6	Total
1966[1]	-	196	196	-	75	-	-	-	-	-	-	-	-	271	271
1967[1]	-	415	415	-	-	-	-	-	-	-	-	-	-	415	415
1968	1426	312	1738	62	-	62	253	67	320	139	2	141	1880	381	2261
1969	1402	426	1828	362	-	362	255	158	413	-	-	-	2019	584	2603
1970	1182	364	1546	140	-	140	61	143	204	34	1	35	1417	508	1925
1971	796	383	1179	63	-	63	18	101	119	1067	-	1067	1944	484	2428
1972	662	266	928	53	52	105	15	97	112	1078	14	1092	1808	429	2237
1973	1095	269	1364	893	42	935	369	50	419	453	22	475	2810	383	3193
1974	1228	507	1735	371	27	398	222	87	309	80	18	98	1901	639	2540
1975	645	428	1073	-	12	12	136	206	342	16	8	24	797	654	1451
1976	279	414	693	-	8	8	17	2	19	8	14	22	304	438	742
1977[2]	779	317	1096	34	18	52	-	-	-	-	-	-	813	335	1148
1978[2]	1648	314	1962	-	-	-	-	-	-	-	-	-	1648	314	1962

[1] ICNAF statistics not categorized into 5Zw and 5Ze.

[2] Provisional.

Source: ICNAF Statistical Bulletins 1966-1976; ICNAF Summary Document 78/VI/28 (Revised 15 June 1978); ICNAF Summary Document 79/VI/30.

Table 3. Percentage of total commercial cod landings from Southern New England (Subdivision 5Zw) and the Middle Atlantic (Statistical Area 6) taken by USA and foreign fisheries, 1968-1978.

YEAR	5Zw			6			5Zw + 6		
	USA	Foreign	Total	USA	Foreign	Total	USA	Foreign	Total
1968	76	24	100	82	18	100	77	23	100
1969	69	31	100	73	27	100	70	30	100
1970	83	17	100	72	28	100	80	20	100
1971	41	59	100	79	21	100	49	51	100
1972	37	63	100	62	38	100	41	59	100
1973	39	61	100	70	30	100	43	57	100
1974	65	35	100	79	21	100	68	32	100
1975	81	19	100	65	35	100	74	26	100
1976	92	8	100	95	5	100	93	7	100
1977	96	4	100	95	5	100	95	5	100
1978	100	-	100	100	-	100	100	-	100
1968-1978	64	36	100	78	22	100	67	33	100

Table 4. Regulatory History of the Subarea 5Z Atlantic Cod Fishery Under ICNAF.

Effective Date	Action	ICNAF Document
26 March 1957	Mesh regulation in trawl fishery: minimum codend mesh of 114 mm (4.5 in) manila twine, measured wet after use or equivalent when measured dry before use; twine other than manila shall have selectivity equal to 114 mm manila trawl net. Incidental cod catch in directed trawl fisheries for other species: 2,265 kg (5,000 lb) or 10% by weight of all fish on board per trip, whichever is greater.	Ann. Proc. 5:11-12
26 March 1957	Amendment to incidental cod catch regulation: 2,265 kg (5,000 lb) or 10% by weight of all fish on board per trip, whichever is greater. OR so long as a person does not catch, in any 12 months, cod in excess of 10% of all trawl-caught fish taken by that person in that 12-month period.	Ann. Proc. 6:16
28 September 1958	Amendment to trawl regulations in force March 1957 concerning the attachment of material to the trawl codend to reduce and prevent gear damage.	Ann. Proc. 7:17
4 July 1969	Amendment to trawl regulations in force March 1957 concerning the use of savings gear which reduce significantly the selectivity of the codend or obstruct the codend meshes.	Ann. Proc. 13:16-17
21 October 1965	Amendment to trawl regulations in force March 1957 specifying mesh size equivalents for material other than manila and for different methods of measurement.	Ann. Proc. 14:17
1 January 1970	Amendments to trawl regulations in force March 1957 providing for standard mesh measuring procedures: 5 kg pressure or pull of ICNAF mesh measuring gauge and measurement of 20 consecutive codend meshes.	Ann. Proc. 17:20
1 January 1970	Closed season and closed area regulations pertaining to haddock spawning areas on Georges Bank: prohibition of fishing with gear capable of catching demersal species (i.e., cod, haddock) during March and April 1970, 1971, and 1972 in the two regions of Georges Bank.	Ann. Proc. 19:27-28
1 January 1972	Amendment to trawl regulations in force March 1957 and subsequently amended effective October 1965: deletes the use of alternative mesh gauges other than the ICNAF gauges.	Ann. Proc. 21:30-31
1 January 1972	Amendment to closed season and closed area regulations in force January 1970 specifying implementation of regulations during every year during March, April, and May.	Ann. Proc. 21:32-33
1 January 1973	International quota regulation for cod fishery in Subdivisions 5Ze and 5Zw of Subarea 5: 35,000 metric ton quota in 1973 with specified national allocations; daily catch record required by all vessels in the fishery.	Ann. Proc. 22:50
1 January 1973	Amendment to closed season and closed area regulations in force January 1970 and subsequently amended effective January 1972 specifying new boundaries for western areas for closure.	Ann. Proc. 22:59
1 January 1974	Amendment to trawl regulations in force March 1957 and subsequently amended effective January 1972: mesh regulation requiring minimum trawl codend meshes of 130 mm (5.1 in) relative to manila netting measured wet after use or the equivalent when measured dry before use; minimum mesh size of 114 mm (4.5 in) in any part of the trawl net other than the codend.	Ann. Proc. 22:65
17 January 1974	Amendment to closed season and closed area regulations in force January 1970 and subsequently amended January 1972 and January 1973 specifying implementation during 1974.	Ann. Rept. 23:86

Table 4. (Cont.)

Effective Date	Action	ICNAF Document
7 May 1974	International quota regulation for cod fishery in Subarea 5Z: 35,000 metric ton quota in 1974 with specified national allocations and reporting procedures.	Ann. Rept. 24:27-29
7 May 1974	Regulation of fishery gear in Subarea 5: prohibition of demersal fishing from 1 July-31 December by vessels over 44.2 m (145 ft) in length within prescribed area in southern New England and Gulf of Maine.	Ann. Rept. 24:30-31
11 January 1975	Amendment to trawl regulation in force March 1957 and subsequently amended effective January 1971 specifying detailed incidental catch provisions.	Ann. Rept. 24:94
11 January 1975	Amendment to the closed season and closed area regulations in force January 1970 and subsequently amended effective January 1972, January 1973, and January 1974 specifying implementation during 1975.	Ann. Rept. 24:96
11 January 1975	Amendment to fishing gear regulation in Subarea 5 in force May 1974: prohibition of demersal fishing from 1 July-31 December by vessels over 44.2 m (145 ft) in length within prescribed area in southern New England, Gulf of Maine, and Statistical Area 6; fishing operations in this area by vessels 39.6 m (130 ft) or larger are to be phased out by 31 December 1976.	Ann. Rept. 24:99
11 January 1975	International quota regulation for cod fishery in Subarea 5Z: 35,000 metric ton quota in 1975 with specified national allocations.	Ann. Rept. 24:101-104
27 July 1975	Amendments to fishing gear regulation in Subarea 5 and Statistical Area 6 in force May 1974 and subsequently amended effective January 1975: prohibition of demersal fishing during the entire year by vessels over 39.6 m (130 ft) within prescribed area in southern New England, Gulf of Maine, and Statistical Area 6; fishing operations in this area by vessels 39.6 (130 ft) or larger are to be phased out by 31 December 1974.	Ann. Rept. 25:29
11 January 1976 16 January 1976	Amendment to closed season and closed area regulations in force January 1970 and subsequently amended effective January 1972, January 1973, January 1974, and January 1975 specifying implementation during 1976.	Ann. Rept. 25:36 Ann. Rept. 25:91
16 January 1976	International quota regulation for cod fishery in Subarea 5Z: 35,000 metric ton quota in 1976 with specified national allocations.	Ann. Rept. 25:94-96
14 April 1976	Amendment to fishing gear regulation in Subarea 5 and Statistical Area 6 in force May 1974 and subsequently amended effective January 1975 and July 1975: prohibition of demersal fishing during the entire year by vessels over 39.6 m (130 ft) within prescribed area in southern New England, Gulf of Maine, and Statistical Area 6 ("Area I"); prohibition of demersal fishing during the entire year by vessels over 47.2 m (155 ft) within prescribed area on Georges Bank ("Area II").	Ann. Rept. 26:37
14 April 1976	Amendment to trawl regulation in force March 1957 and subsequently amended effective January 1971 and January 1975: specified maximum incidental catch of cod taken with less than regulation codend mesh (130 mm) to be 2,500 kg (5,510 lb) or 10% by weight of all fish on board of vessel, whichever is greater.	Ann. Rept. 26:41
14 April 1976	Amendment to international quota regulation for cod fishery in Subarea 5Z in force January 1976: 35,000 metric ton quota in 1976; slight modification in national allocations (Cuba allocated 400 metric tons of cod from "Others" category).	Ann. Rept. 26:42-43
25 December 1976	International quotas regulation for cod fishery in Subarea 5Z: 20,000 metric ton quota in 1977 with specified national allocations.	Ann. Rept. 26:115-118
17 June 1977	Repeal of fishing gear regulation in Subarea 5 and Statistical Area 6 enacted 14 April 1976 (Ann. Rept. 26:37).	

Table 5. THE REGULATORY HISTORY OF THE NEW ENGLAND/MID-ATLANTIC GROUNDFISHERY, MARCH 15, 1977 TO JULY, 1979.

Federal Register Notice	Action	Comments	Effective Date
March 14, 1977 (FR p. 13998)	Emergency Regulations	NOAA approval of Council FMP and implementation under emergency rules for 45 days.	March 15, 1977
April 29, 1977 (FR p. 21784)	Extension of Emergency Regulations		April 1, 1977
June 10, 1977 (FR p. 29875)	Final Regulations	Implementation of FMP and subsequent amendments as final regulations.	June 13, 1977
July, 1977	Closure of the directed commercial cod fishery in 5Y.	U.S. commercial allocation for 1977 reached.	July 8, 1977
August, 1977 (Press Release)	Closure of the directed commercial cod fishery in 5Z/5A6.	U.S. share of 20,000 MT OY for 1977 reached. Incidental fishery permitted to continue.	August 22, 1977
November 9, 1977 (FR p.)	Emergency Amendment to regulations.	Increase in OYs for cod, haddock and yellowtail to meet emergency in industry.	November 2, 1977
December 20, 1977 (P.R. NMFS)	Closure of commercial groundfish fisheries in FCZ.	Emergency regulations of Nov. 3 expired. Original quotas already taken.	December 23-30, 1977
December 30, 1977 (FR p. 65188)	Emergency Regulations	Amendment of final regulations (June 10) to extend them from Jan. 1, 1978-Feb. 14, 1978.	Jan. 1-Feb. 14, 1978
February 13, 1978 (FR p. 6094)	Extension of emergency regulations.		Feb. 15-Mar. 31, 1978
March 1, 1978 (FR p. 8282)	Closure of directed commercial cod fishery in 5Z/5A6 and 5Y.	50 percent of 1st quarter cod quotas taken.	Mar. 1-31, 1978
March 17, 1978 (FR p. 11247)	Closure of commercial by-catch fishery for cod in 5Z/5A6.	Total quarterly cod quota taken in 5Z/5A6.	Mar. 19-31, 1978
March 31, 1978 (FR p. 13578)	Interim Emergency Regulations	NOAA approval of Council amendment to FMP.	April 1, 1978
April 10, 1978 (FR p. 14968)	Interim emergency amendment to regulations.	Change of the cod fishery from an open directed fishery to a limited fishery.	April 13, 1978
April 24, 1978 (FR p. 17861)	Interim emergency amendment to regulations	Changes in definitions in vessel classes and the introduction of weekly rather than daily landing restrictions for cod and haddock.	April 30, 1978
May 3, 1978 (FR p. 19060)	Revision of quarterly quotas.	1st quarter catches of cod, haddock and yellowtail exceeded quotas. Overage deducted from remaining quotas.	May 3, 1978
May 5, 1978 (FR p. 19429)	Amendment to landing restrictions.	40 percent of 2nd quarter allocations of cod, haddock and yellowtail taken. Lowering of landing restrictions.	May 7, 1978
June 25, 1978 (FR p. 27548)	Amendment to landing restrictions.	Further downward adjustments in landing restrictions to allow vessel classes to harvest on an annual basis their historical shares of cod and haddock.	July 2, 1978
June 30, 1978 (FR p. 29503)	Final Regulations	Implementation of Interim Emergency Regulations of March 31, 1978 with subsequent amendments as final regulations.	July 1, 1978
July 19, 1978 (FR 31015)	Emergency amendments to regulations.	Addition of a no discard rule, new minimum mesh size, increases in OYs for haddock, cod 5Y, 1 percent incidental catch of cod, or haddock during closures by vessels with small mesh nets.	July 19-Aug. 1, 1978
July 21, 1978 (FR p. 31341)	Amendment to regulations including landing restrictions.	Assignment of annual allocations for vessel groups. Adjustment of weekly per vessel catch limitations.	July 22, 1978
July 27, 1978	Closure of cod fishery in 5Y for vessels 61-125 GRT and fixed gear.	Vessels in these gear/size classes have taken their annual allocations.	August 5, 1978
August 10, 1978 (FR p. 35488)	Closure of all commercial cod fishing in 5Y.	Annual commercial cod quota for 5Y exceeded.	August 16, 1978

Table 5. (continued)

Federal Register Notice	Action	Comments	Effective Date
September 1, 1978 (FR p. 39108)	Extension of Emergency Regulations	Emergency amendments to final regulations of July 19 extended for another 45 days.	Aug. 30-Oct. 14, 1978
September 18, 1978 (FR p. 41405)	Closure of commercial cod fishing in 5Z/SA6 for vessels 61-125 GRT.	Vessels in this class have taken their annual quota.	September 17, 1978
September 21, 1978 (FR p. 42764)	Amendment to landing restrictions.	Revision of yellowtail flounder per vessel landing restrictions of July 23.	September 17, 1978
October 4, 1978 (43 FR 45872)	Approval of FMP amendment establishing new fishing year; emergency and proposed regulations.	New fishing year from October 1 to September 30 adopted; reinstatement of OYs and quotas adopted in March, 1978.	October 1, 1978
November 9, 1978 (43 FR 52252)	Notice of fishery closures; adjustments to catch limitations (for four vessel classes)	Closures in nine fisheries because between 38 and 92 percent of quotas for entire quarter were taken in first month.	November 12, 19, 25, 1978
November 15, 1978 (43 FR 53040)	Extension of Emergency Regulations; correction of closure notices and catch limit adjustments.	—	November 19, 1978
December 15, 1978 (43 FR 58570)	Closure of five additional fisheries: haddock and cod 5Y fixed gear; cod 5Z/SA6 over 125 GRT; haddock 5Z/SA6 61-125 GRT; yellowtail flounder W of 69° all vessels.	Vessels in these gear/size classes have taken their quarterly allocations.	December 17, 1978 thru January 1, 1979
January 1, 1979 (44 FR 885)	Final Regulations	Final promulgation of emergency regulations of October 4; intended to provide interim management while new FMP is prepared.	December 29, 1978
January 11, 1979	Correction of regulations.	Addition of Appendix A and B to final regulations, showing quarterly quotas and catch limitations by vessel class.	January 11, 1979
February 2, 1979 (44 FR 6732)	Final regulation on quarterly quotas and notice of fishery closures and adjustments of catch limitation.	Adjusts quarterly quotas to reflect reported landings for first quarter and deduct overages from subsequent quarter quotas. Closures of cod 5Y 61-125 GRT; haddock 5Y 0-60 GRT and 61-125 GRT; yellowtail flounder W of 69° all vessels.	February 4, 1979
March 16, 1979	Notice of fishery opening and subsequent annual closure; establishment of catch limitations; correction of regulation.	Reopens fisheries with new reduced catch limitations; yellowtail flounder closure 4/29/79, corrects error in regulations which provided that closures were required to meet quarterly quotas.	March 13, 1979; yellowtail flounder closure April 28, 1979
April 17, 1979	Notice of fishery closures	Closure of cod 5Y 61-125 GRT; haddock 5Y 61-125 GRT. Vessels in these classes have taken their annual quota.	April 22, 1979
April 24, 1979 (44 FR 24079)	Notice of closure of yellowtail flounder fishery west of 69°W longitude until 1 October 1979.	Annual optimum yield for fishery taken.	April 28, 1979
July 23, 1979 (44 FR 42977)	Approval and partial disapproval of amendment to FMP, promulgation of emergency regulation; notice of adjustments to catch limitations and of fishery closures.	Increases OY and commercial quotas for 5Y and 5Z+6 cod and haddock; revision of commercial quarterly quotas consistent with OY increases; adjusts weekly catch limitations. Closure of cod 5Y for 0-60 GRT and fixed gear classes. Emergency regulation prohibiting "piggybacking".	July 22, 1979

Table 6. Total number of Atlantic cod and number of juvenile cod (<37 cm length) caught in USA spring and autumn bottom trawl surveys in Southern New England and the Middle Atlantic (Strata 1-2, 5-6, 9-10, 65, 69-70 and 73-74), 1963-1979.

	Spring		Autumn	
Year	No. of cod caught	No. of cod <37 cm	No. of cod caught	No. of cod <37 cm
1963	-	-	18	0
1964	-	-	4	0
1965	-	-	13	2
1966	-	-	15	1
1967	-	-	48	8
1968	63	14	16	3
1969	107	6	27	0
1970	56	2	13	1
1971	47	5	7	2
1972	45	6	30	1
1973	226	13	0	0
1974	42	3	10	5
1975	49	3	34	3
1976	31	4	24	2
1977	34	0	3	0
1978	76	53	9	3
1979	73	25		
Total	849	134	271	31

Table 7. NEFC inshore research bottom trawl survey cruises, Block Island to Cape Hatteras (Inshore strata 1-44), 1972-1978. The total number of Atlantic cod caught in each survey is indicated as well as the number of cod caught that were less than 37 cm in length (juvenile cod).

Season	Year	Cruise Number	Research Vessel	Trawl Type	# of Stations	# of Cod Caught	# of Cod <37cm
Autumn	1972	72-01	ATLANTIC TWIN	3/4 Yankee	124	5	0
Spring	1973	73-02	ATLANTIC TWIN	3/4 Yankee	166	1	0
Autumn	1973	73-03	ATLANTIC TWIN	3/4 Yankee	132	0	0
Apring	1974	-	ATLANTIC TWIN DELAWARE II	3/4 Yankee 3/4 Yankee	109	48	1
Autumn	1974	74-11 74-12	ALBATROSS IV DELAWARE II	36 Yankee 36 Yankee	79	0	0
Spring	1975[1]	-	ATLANTIC TWIN	3/4 Yankee	36	53	0
Autumn	1975	75-01	DELAWARE II	36 Yankee	94	1	0
Spring	1976	76-05	DELAWARE II	41 Yankee	75	20	0
Autumn	1976	76-09	ALBATROSS IV	36 Yankee	73	0	0
Spring	1977[2]	77-03	DELWARE II	41 Yankee	63	8	0
Summer	1977	77-07 77-09	ALBATROSS IV DELAWARE II	36 Yankee 36 Yankee	79	0	0
Autumn	1977	77-12	DELAWARE II	36 Yankee	72	0	0
Winter	1978[1]	78-01	ALBATROSS IV	41 Yankee	67	54	0
Spring	1978	78-04	ALBATROSS IV	41 Yankee	67	39	9
Summer	1978	78-09	ALBATROSS IV	36 Yankee	70	0	0
Autumn	1978	78-06	DELAWARE II	36 Yankee	73	0	0
Spring	1979	79-03 79-04	ALBATROSS IV DELAWARE II	41 Yankee 41 Yankee	71	39	7

[1]Survey conducted only from Block Island to Delaware Bay.

[2]Survey conducted only from Shinnecock, Long Island to Cape Hatteras.

Table 8. Total number of tows accomplished in USA spring bottom trawl surveys in Southern New England and the Middle Atlantic (Strata 1-2, 5-6, 9-10, 65, 69-70 and 73-74), 1968-1979.

Year	Stratum 1	2	5	6	9	10	65	69	70	73	74	Total
1968	6	5	4	6	4	6	8	7	4	6	4	60
1969	7	7	5	8	5	8	8	7	4	5	4	68
1970	7	9	5	9	5	10	6	7	5	6	5	74
1971	8	7	5	11	6	9	8	6	4	6	5	75
1972	7	8	5	9	5	8	8	7	4	6	4	71
1973	16	14	10	16	5	8	7	6	4	9	6	101
1974	7	6	4	8	4	8	3	5	4	5	4	58
1975	8	8	6	9	5	7	1	4	4	6	4	62
1976	8	7	5	9	5	10	9	9	4	7	5	78
1977	7	7	5	8	6	9	9	10	4	8	5	78
1978	8	8	7	10	5	8	7	7	4	6	4	74
1979	7	7	10	8	15	8	6	6	6	5	5	83

Table 9. Total number of Atlantic cod caught in USA spring bottom trawl surveys in Southern New England and the Middle Atlantic (Strata 1-2, 5-6, 9-10, 65, 69-70, and 73-74), 1968-1979.

Year	Stratum 1	2	5	6	9	10	65	69	70	73	74	Total
1968	4	1	4	3	20	24	1	1	1	4	-	63
1969	6	-	56	1	30	7	1	3	-	3	-	107
1970	4	5	13	1	20	8	-	3	-	2	-	56
1971	4	1	13	2	16	4	1	2	-	4	-	47
1972	1	-	4	-	30	3	-	-	-	2	-	45
1973	49	2	50	7	11	23	4	56	-	16	3	225
1974	9	-	5	-	6	3	-	5	-	9	-	42
1975	10	-	5	-	14	17	-	-	-	3	-	49
1976	14	-	-	-	5	5	-	-	-	6	-	31
1977	8	-	6	2	6	8	-	3	-	2	-	34
1978	2	23	-	2	14	33	-	-	-	2	-	76
1979	5	-	8	-	55	5	-	-	-	-	-	73

Table 10. Total weight (lbs) of Atlantic cod caught in USA spring bottom trawl surveys in Southern New England and the Middle Atlantic (Strata 1-2, 5-6, 9-10, 65, 69-70, and 73-74), 1968-1979.

Year	Stratum 1	2	5	6	9	10	65	69	70	73	74	Total
1968	81	32	7	62	66	49	13	11	3	27	--	350
1969	131	--	134	12	107	64	36	23	--	39	--	596
1970	39	59	172	5	173	87	--	15	--	13	--	563
1971	31	11	127	27	136	54	22	9	--	52	--	469
1972	15	--	56	--	135	119	--	--	--	34	--	409
1973	200	3	410	132	35	134	8	180	--	95	5	1202
1974	103	--	30	--	59	66	--	59	--	54	--	391
1975	125	--	75	--	50	208	--	--	--	40	--	500
1976	192	--	--	--	47	21	--	--	--	91	--	351
1977	140	--	44	22	21	35	--	51	--	31	--	344
1978	44	--	54	30	58	60	--	--	--	57	--	303
1979	32	--	102	--	251	73	--	--	--	--	--	324

Table 11. Number of tows, total number of Atlantic cod caught and total weights (lbs) of Atlantic cod caught in USA autumn bottom trawl surveys in Southern New England (Strata 1, 5, 6, 9 and 10), 1963-1978.

	Tows Stratum						Number of cod caught Stratum						Weight of cod caught (lbs) Stratum					
Year	1	5	6	9	10	Total	1	5	6	9	10	Total	1	5	6	9	10	Total
1963	5	4	7	4	4	24	9	1	-	8	-	18	111	9	-	99	-	219
1964	4	5	5	5	5	24	-	-	-	3	1	4	-	-	-	28	14	42
1965	4	3	5	5	5	22	2	10	-	1	-	13	34	72	-	8	-	114
1966	4	5	5	5	5	24	-	7	-	8	-	15	-	46	-	34	-	80
1967	9	4	9	6	6	34	7	16	3	15	7	48	64	110	17	71	33	295
1968	9	5	7	7	9	37	4	11	-	1	-	16	38	29	-	27	-	94
1969	7	7	11	5	8	38	-	18	5	4	-	27	-	170	31	31	-	232
1970	9	5	8	7	9	38	-	4	-	-	9	13	-	12	-	-	52	64
1971	8	8	11	8	11	46	-	2	-	3	2	7	13	-	-	6	5	24
1972	7	7	11	5	9	39	-	-	-	29	1	30	-	-	-	224	4	228
1973	8	5	8	5	8	34	-	-	-	-	-	-	-	-	-	-	-	-
1974	6	6	8	5	8	33	-	6	-	-	4	10	-	8	-	-	27	35
1975	8	6	9	5	9	37	-	-	-	34	-	34	-	-	-	268	-	268
1976	8	6	8	5	8	35	-	-	-	24	-	24	-	-	-	126	-	126
1977	7	5	7	5	9	33	-	-	-	2	1	3	-	-	-	18	5	23
1978	8	10	17	10	16	61	-	2	-	6	1	9	-	16	-	68	7	91

Table 12. Number of tows, total number of Atlantic cod caught, total weight (lbs) of Atlantic cod caught, and mean weight per cod caught in USA spring and autumn bottom trawl surveys in Southern New England and the Middle Atlantic (Strata 1-2, 5-6, 9-10, 65, 69-70 and 73-74), 1963-1979. Number of tows in the autumn surveys only includes tows in Strata 1,5,6,9 and 10 since cod have never been taken in tows in more southerly strata during the autumn cruises.

	Spring				Autumn			
Year	Number of tows	Total No. of cod caught	Total weight (lbs) of cod caught	Mean weight (lbs) per fish	Number of tows	Total No. of cod caught	Total weight (lbs) of cod caught	Mean weight (lbs) per fish
1963	-	-	-	-	24	18	219	12.2
1964	-	-	-	-	24	4	42	10.5
1965	-	-	-	-	22	13	114	8.8
1966	-	-	-	-	24	15	80	5.3
1967	-	-	-	-	34	48	295	6.1
1968	60	63	350	5.6	37	16	94	5.9
1969	68	107	596	5.6	38	27	232	8.6
1970	74	56	563	10.1	38	13	64	4.9
1971	75	47	469	10.0	46	7	24	3.4
1972	71	45	409	9.1	39	30	228	7.6
1973	101	226	1202	5.3	34	0	0	0
1974	58	42	391	9.3	33	10	35	3.5
1975	62	49	500	10.2	37	34	268	7.9
1976	78	31	351	11.3	35	24	126	5.3
1977	78	34	344	10.1	33	3	23	7.7
1978	74	76	303	4.0	61	9	91	10.1
1979	83	73	524	7.2				

Table 13. Stratified mean catch per tow in numbers and weight (lbs) for Atlantic cod from USA spring and autumn bottom trawl surveys in Southern New England and the Middle Atlantic, 1963-1979. Spring survey data include strata 1-2, 5-6, 9-10, 65, 69-70 and 73-74. Autumn survey data are limited to strata 1,5,6,9, and 10 since cod were never taken in more southerly strata in any of the autumn cruises.

Year	Spring[1]		Autumn	
	Nos.	Wt. (lbs)	Nos.	Wt. (lbs)
1963	-	-	0.74	8.98
1964	-	-	0.14	1.50
1965	-	-	0.60	5.49
1966	-	-	0.42	2.22
1967	-	-	1.45	8.92
1968	1.14	6.29	0.42	2.32
1969	1.47	8.73	0.57	4.86
1970	0.74	7.35	0.36	1.79
1971	0.61	6.10	0.13	0.44
1972	0.62	5.80	0.85	6.43
1973	2.58	11.94	0.00	0.00
1974	0.73	6.78	0.26	1.03
1975	0.72	7.47	0.96	7.56
1976	0.42	4.79	0.68	3.55
1977	0.45	4.74	0.08	0.63
1978	0.98	4.05	0.13	1.28
1979	0.45	4.32		

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

Table 14. Stratified mean catch per tow at age (numbers) of Atlantic cod from USA spring bottom trawl surveys in Southern New England and the Middle Atlantic (Strata 1-2, 5-6, 9-10, 65, 69-70, and 73-74), 1970-1978.[1]

	Age												Totals					
Year	0	1	2	3	4	5	6	7	8	9	10	11	0+	1+	2+	3+	4+	5+
1970	.000	.026	.000	.093	.429	.054	.077	.026	.020	.007	.000	.013	.745	.745	.719	.719	.626	.197
1971	.031	.022	.049	.055	.070	.245	.030	.068	.024	.013	.000	.000	.607	.576	.554	.505	.450	.380
1972	.000	.079	.130	.142	.015	.053	.109	.023	.058	.016	.000	.000	.625	.625	.546	.416	.274	.259
1973	.018	.000	2.030	.053	.147	.079	.065	.116	.040	.015	.000	.015	2.578	2.560	2.560	.530	.477	.330
1974	.051	.000	.000	.384	.071	.134	.000	.055	.017	.000	.017	.000	.729	.678	.678	.678	.294	.223
1975	.000	.026	.084	.079	.397	.000	.034	.026	.045	.031	.000	.000	.722	.722	.696	.612	.533	.136
1976	.000	.013	.062	.016	.025	.268	.033	.000	.000	.000	.000	.000	.417	.417	.404	.342	.326	.301
1977	.000	.000	.151	.054	.000	.048	.182	.000	.000	.000	.016	.000	.451	.451	.451	.300	.246	.246
1978	.621	.060	.000	.135	.059	.011	.016	.046	.013	.005	.016	.000	.982	.361	.301	.301	.166	.107

[1]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 15. Stratified mean catch per tow at age (numbers) of Atlantic cod from USA autumn bottom trawl surveys in Southern New England (Strata 1, 5, 6, 9, and 10), 1970-1978.

Year	Age												Totals					
	0	1	2	3	4	5	6	7	8	9	10	11	0+	1+	2+	3+	4+	5+
1970	.000	.055	.167	.082	.056	.000	.000	.000	.000	.000	.000	.000	.360	.360	.305	.138	.056	.000
1971	.035	.041	.041	.000	.000	.000	.017	.000	.000	.000	.000	.000	.134	.099	.058	.017	.017	.017
1972	.000	.084	.340	.211	.125	.000	.056	.000	.028	.000	.000	.000	.844	.844	.760	.420	.209	.084
1973	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
1974	.114	.000	.000	.150	.000	.000	.000	.000	.000	.000	.000	.000	.264	.150	.150	.150	.000	.000
1975	.000	.140	.112	.283	.394	.000	.028	.000	.000	.000	.000	.000	.957	.957	.817	.705	.422	.394
1976	.000	.225	.324	.043	.000	.084	.000	.000	.000	.000	.000	.000	.676	.676	.451	.127	.084	.084
1977	.000	.000	.056	.028	.000	.000	.000	.000	.000	.000	.000	.000	.084	.084	.084	.028	.000	.000
1978	.014	.028	.000	.058	.014	.000	.000	.014	.000	.000	.000	.000	.128	.114	.086	.086	.028	.014

Table 16. Comparison of the relative dominance of the 1966, 1971, and 1975 year-classes of Atlantic cod between Southern New England and the Mid-Atlantic, and Georges Bank as derived from USA spring bottom trawl surveys, 1970-1978. Values listed represent the percentage of the total stratified mean number per tow that was due to each of the year-classes in each area during the spring surveys.

Year-Class/Area	Age									
	0	1	2	3	4	5	6	7	8	9
1966										
Southern New England - Mid-Atlantic	-	-	-	-	-	57.4	40.4	17.4	4.5	2.3	4.3
Georges Bank	-	-	-	-	-	29.8	17.3	3.6	0.7	1.7	1.6
1971										
Southern New England - Mid-Atlantic	5.1	12.6	78.7	52.7	55.0	64.3	40.4	4.7		
Georges Bank	0.0	32.4	73.1	40.5	44.9	22.3	11.5	5.8		
1975										
Southern New England - Mid-Atlantic	0.0	3.1	33.5	13.7						
Georges Bank	0.0	18.4	56.0	44.9						

Table 17. Estimated total instantaneous mortality rates (Z) for Atlantic cod from USA spring research vessel bottom trawl survey catch (numbers) at age data in Southern New England and the Middle Atlantic (Strata 1-2, 5-6, 9-10, 65, 69-70, and 73-74), 1970-1978.

	Age 3+	Age 4+	Age Group			
Year	Z[1]	Z[2]	3-4	4-5	5-6	6-7
1970						
	0.47	0.50	0.28	0.56	0.59	0.12
1971						
	0.61	0.55	1.30	0.28	0.81	0.27
1972						
	_[3]	_[3]	_[3]	_[3]	_[3]	_[3]
1973						
	0.59	0.76	-0.29	0.09		0.17
1974						
	0.24	0.77	-0.03		1.37	
1975						
	0.63	0.57	1.15	0.39		
1976						
	0.33	0.28		-0.65	0.39	
1977						
	0.59	0.83	-0.09		1.10	1.38
1978						
Average Z (r..) 1973-1978	0.45	0.62				

[1] Calculated as $\ln\left(\frac{\Sigma \text{ ages } 3+ \text{ in year } i}{\Sigma \text{ ages } 4+ \text{ in year } i+1}\right)$

[2] Calculated as $\ln\left(\frac{\Sigma \text{ ages } 4+ \text{ in year } i}{\Sigma \text{ ages } 5+ \text{ in year } i+1}\right)$

[3] Not calculated due to gear conversion in 1973

Table 18. Mean length of fish (cm), at age, of Atlantic cod from USA spring bottom trawl surveys, 1970-1978, in Southern New England and the Middle Atlantic (Strata 1-2, 5-6, 9-10, 65, 69-70, and 73-74). Standard deviation of mean length is presented in parentheses.

Survey Year	Age									
	0	1	2	3	4	5	6	7	8	9
1970		20.00	-	57.32	67.70	78.78	89.35	89.92	92.00	95.00
		(3.00)	-	(3.39)	(4.14)	(3.29)	(6.49)	(7.48)	-	-
1971	3.74	23.00	41.80	57.96	67.31	75.87	75.80	92.26	104.00	119.00
	(1.48)	-	(6.17)	(4.44)	(7.03)	(6.55)	(7.96)	(6.30)	-	-
1972		21.94	47.05	60.82	80.00	80.34	84.60	90.70	98.00	98.00
		(4.48)	(6.01)	(6.31)	-	(6.13)	(7.53)	(1.49)	(3.00)	-
1973	5.00	-	42.75	62.17	67.12	81.94	83.14	98.05	98.08	92.00
	-	-	(3.73)	(4.57)	(8.74)	(7.13)	(7.39)	(4.09)	(6.66)	-
1974	5.00	-	-	58.06	67.41	79.51	-	94.35	89.00	-
	-	-	-	(6.64)	(10.70)	(6.30)	-	(3.78)	-	-
1975		20.00	40.71	62.38	71.61	-	92.00	90.27	99.20	101.00
		(6.00)	(3.57)	(5.19)	(6.43)	-	-	(9.99)	(2.40)	-
1976		26.00	36.79	68.75	75.32	82.07	89.73	-	-	-
		-	(7.14)	(1.30)	(1.49)	(5.17)	(5.06)	-	-	-
1977			43.19	60.56	-	84.00	86.53	-	-	-
			(3.64)	(5.02)	-	(2.47)	(5.72)	-	-	-
1978	4.85	19.25	-	61.38	78.73	80.82	95.00	96.83	98.00	104.00
	(0.66)	(2.49)	-	(5.27)	(4.29)	(2.89)	-	(3.67)	-	-

Table 19. Mean length of fish (cm), by age, of Atlantic cod from USA spring bottom trawl surveys, 1970-1978, on Georges Bank (Strata 13-25). Standard deviation of mean length is presented in parentheses.

Survey Year	Age 0	1	2	3	4	5	6	7	8	9
1970		24.33 (5.20)	44.17 (3.41)	58.12 (3.67)	67.16 (5.95)	77.75 (7.97)	78.77 (8.03)	86.22 (6.40)	90.23 (11.50)	105.10 (9.03)
1971		23.32 (2.97)	42.01 (6.08)	59.03 (5.72)	65.38 (6.80)	74.17 (5.45)	80.10 (5.97)	86.80 (8.24)	94.40 (6.98)	92.00 (5.04)
1972	5.00 -	22.35 (4.51)	43.70 (5.28)	57.93 (5.36)	68.76 (6.16)	71.08 (4.77)	83.06 (7.14)	83.88 (7.70)	92.94 (8.74)	107.65 (4.71)
1973	5.00 -	20.50 (2.87)	43.93 (4.05)	57.69 (5.33)	66.78 (5.67)	73.26 (8.00)	74.01 (8.09)	90.14 (9.03)	91.63 (4.36)	100.76 (7.53)
1974		22.77 (6.52)	40.53 (4.55)	56.71 (5.93)	66.84 (6.27)	77.40 (7.68)	83.87 (7.16)	92.74 (7.82)	90.29 (6.19)	95.00 -
1975		27.98 (8.42)	43.11 (9.12)	61.24 (6.61)	65.56 (7.96)	76.62 (7.15)	87.23 (9.92)	85.02 (10.76)	95.30 (12.51)	98.91 (6.28)
1976	5.00 -	25.18 (4.68)	44.03 (8.43)	56.19 (9.07)	70.14 (7.43)	72.72 (9.23)	80.09 (9.88)	91.98 (7.87)	95.26 (8.57)	- -
1977		27.67 (1.49)	44.38 (5.16)	60.37 (6.04)	72.05 (9.13)	83.23 (9.74)	86.41 (7.56)	92.82 (6.28)	93.07 (12.76)	- -
1978	5.16 (0.68)	24.46 (3.41)	39.93 (7.04)	57.15 (5.70)	70.34 (7.15)	75.36 (12.52)	85.02 (9.76)	93.60 (8.44)	96.09 (1.44)	103.51 (4.82)

Table 20. Calculated mean lengths (fork length, cm) at age for Southern New England-Middle Atlantic cod obtained from fitting a von Bertalanffy growth curve to pooled (1970-1978) mean length at age data from NEFC spring bottom trawl surveys.

Age	# of Cod Aged	Age Samples Expanded	Fork Length (cm) Pooled Mean Length	Fork Length (cm) Calculated[1] Mean Length
1.3	16	19	21.42	21.81
2.3	123	206	42.70	42.46
3.3	70	84	59.82	58.44
4.3	84	108	69.69	70.79
5.3	66	73	79.67	80.34
6.3	41	47	87.28	87.73
7.3	31	34	94.47	93.44
8.3	12	17	97.65	97.86
9.3	8	10	101.30	101.38

[1]Derived from the equation $\ell_t = 112.94\ (1 - e^{-0.257(t-0.465)})$

Table 21. Percentage, by gear type, of USA commercial Atlantic cod landings (metric tons, live) from Southern New England (Subdivision 5Zw), by year, 1968-1978.

	Gear Type				
Year	Otter Trawl	Line Trawl	Hand Line	Other	Total
1968	97.8	----	2.1	0.1	100.0
1969	95.6	0.9	3.3	0.1	99.9
1970	97.2	0.9	1.6	0.3	100.0
1971	95.7	1.4	1.7	1.1	99.9
1972	96.0	2.1	1.5	0.4	100.0
1973	95.5	3.4	0.7	0.4	100.0
1974	91.7	4.8	1.9	1.6	100.0
1975	78.3	13.9	2.6	5.2	100.0
1976	76.1	17.0	0.7	6.2	100.0
1977	96.9	2.9	0.1	0.1	100.0
1978	98.5	1.5	0.3	7.7	100.0
1968-1978	93.2	3.2	1.5	2.1	100.0

Table 22. Atlantic cod landings (metric tons, live) by USA otter trawlers fishing in Southern New England (Subdivision 5Zw) and landing in New England ports, by month, 1968-1978.

Year	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1968	219	193	128	73	60	129	22	2	1	31	74	73	1005
1969	317	156	279	119	59	30	5	1	5	30	54	41	1096
1970	118	129	219	256	74	16	11	8	2	19	86	79	1017
1971	65	102	160	125	46	19	15	3	1	7	33	98	674
1972	78	78	97	109	25	14	2	1	-	7	104	134	649
1973	164	102	177	236	83	5	-	-	-	3	53	223	1046
1974	259	101	206	306	98	6	2	-	-	3	72	65	1118
1975	55	37	144	139	68	5	2	-	-	1	21	27	499
1976	45	19	41	39	12	2	1	-	-	1	29	22	211
1977	60	64	109	300	36	10	1	-	-	3	47	117	747
1978	178	444	276	330	67	28	5	1	-	1	29	119	1478
Total	1558	1425	1836	2032	628	264	66	16	9	106	602	998	9540
% by Month	16.3	14.9	19.2	21.3	6.6	2.8	0.7	0.2	0.1	1.1	6.3	10.5	100.0

Table 23. Atlantic cod landings (metric tons, live) by USA otter trawlers fishing in Southern New England (Subdivision 5Zw) and landing in New England ports for trips in which 50% or more of the total trip catch weight was cod (directed catch), by month, 1968-1978.

Year	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1968	92	82	35	2	-	13	-	-	-	-	5	10	239
1969	87	45	60	4	2	-	1	-	-	-	-	6	205
1970	15	45	75	16	1	-	-	2	-	1	20	23	198
1971	13	33	62	6	-	-	-	-	-	-	5	26	145
1972	27	11	22	24	1	8	1	-	-	1	45	56	196
1973	55	17	28	26	1	-	-	-	-	2	20	112	261
1974	134	25	119	126	13	-	-	-	-	-	35	35	487
1975	21	19	70	42	-	-	-	-	-	-	1	11	164
1976	26	1	5	-	-	-	-	-	-	-	7	5	44
1977	7	16	48	211	4	2	-	-	-	-	22	74	384
1978	117	261	204	173	24	15	-	-	-	-	11	35	840
Total	594	555	728	630	46	38	2	2	-	4	171	393	3163
% by Month	18.8	17.5	23.0	19.9	1.5	1.2	0.1	0.1	-	0.1	5.4	12.4	100.0

Table 24. Atlantic cod effort (day fished), by vessel tonnage class (class 2: 0-50 GRT; class 3: 51-150 GRT; class 4: 151-300 GRT), for USA otter trawl trips catching cod from Southern New England (Subdivision 52w) and landing in New England ports, 1968-1978. For each vessel class, the number of days fished in trips in which cod comprised 50% or more of the total trip catch weight (directed effort) is presented, and the percentage of the total days fished that were days fished in directed efforts trips is indicated.

	Class 2			Class 3			Class 4			All Classes		
Year	Total Effort	Directed Effort	%Effort Directed	Total Effort	Directed Effort	%Effort Directed	Total Effort	Directed Effort	%Effort Directed	Total Effort	Directed Effort	%Effort Directed
1968	944	58	6.0	658	21	3.3	20	--	----	1622	79	4.9
1969	827	36	4.4	697	14	2.0	--	--	----	1524	50	3.3
1970	855	39	4.6	524	10	1.9	--	--	----	1379	49	3.6
1971	735	37	5.0	602	16	2.7	6	--	----	1343	53	3.9
1972	582	41	7.0	638	29	4.5	3	2	66.7	1223	72	5.9
1973	659	74	11.2	693	45	6.5	1	--	----	1353	119	8.8
1974	773	102	13.1	834	87	10.4	4	1	25.0	1616	190	11.8
1975	689	66	9.6	530	24	4.1	13	3	23.1	1232	93	7.3
1976	466	9	1.9	379	14	3.7	--	--	----	845	23	2.7
1977	454	20	4.4	566	41	7.2	1	1	100.0	1021	62	6.1
1978	456	56	12.3	740	163	22.0	6	4	66.7	1202	223	18.6

Table 25. Vessel trips in which Atlantic cod was landed, by vessel tonnage class (class 2: 0-50 GRT; class 3: 51-150 GRT; class 4: 151-300 GRT), for USA otter trawlers fishing in Southern New England (Subdivision 52w) and landing in New England ports, 1968-1978. For each vessel class, the number of trips in which cod comprised 50% or more of the total trip catch weight (directed trip) is presented, and the percentage of the total trips that were directed cod trips is indicated.

	Class 2			Class 3			Class 4			All Classes		
Year	Total Trips	Directed Trips	%Trips Directed	Total Trips	Directed Trips	%Trips Directed	Total Trips	Directed Trips	%Trips Directed	Total Trips	Directed Trips	%Trips Directed
1968	3000	174	5.8	470	30	6.4	4	--	-----	3474	204	5.9
1969	2523	142	5.6	606	21	3.5	--	--	-----	3129	163	5.2
1970	2493	163	6.5	667	16	2.4	--	--	-----	3160	179	5.7
1971	1940	150	7.7	609	20	3.3	1	--	-----	2549	170	6.7
1972	1054	129	12.2	424	20	4.7	2	1	50.0	1480	150	10.1
1973	1071	113	10.6	545	36	6.6	1	--	-----	1617	149	9.2
1974	1543	126	8.2	763	74	9.7	4	1	25.0	2310	201	8.7
1975	1154	68	5.9	505	19	3.8	12	5	41.7	1671	92	5.5
1976	790	22	2.8	351	14	4.0	--	--	-----	1141	36	3.2
1977	826	24	2.9	625	51	8.2	1	1	100.0	1453	76	5.2
1978	731	73	10.0	683	109	16.0	5	2	40.0	1469	139	12.9

Table 26. Commercial landings (metric tons live) of Atlantic cod, by vessel tonnage class (class 2:0-50 GRT; class 3:51-150 GRT; class 4:151-300 GRT), for USA otter trawlers fishing in Southern New England (Subdivision 52w) and landing in New England ports, 1968-1978. For each vessel class, cod landings from trips in which 50% or more of the total trip catch weight was cod (directed catch) is presented, and the percentage of the total catch landed in the directed catch is indicated.

	Class 2			Class 3			Class 4			All Classes		
Year	Total Catch	Directed Catch	%Catch Directed	Total Catch	Directed Catch	%Catch Directed	Total Catch	Directed Catch	%Catch Directed	Total Catch	Directed Catch	%Catch Directed
1968	677	168	24.8	288	72	25.0	40	--	-----	1005	240	23.9
1969	673	152	22.6	420	51	12.1	--	--	-----	1093	203	18.6
1970	636	135	20.6	362	61	16.9	--	--	-----	1018	196	19.3
1971	405	89	22.0	267	55	20.6	1	--	-----	673	144	21.4
1972	530	104	19.7	291	84	28.9	3	3	100.0	849	196	30.2
1973	477	142	29.8	565	118	20.9	2	--	-----	1044	260	24.9
1974	476	221	46.4	637	260	40.8	6	5	83.3	1119	486	43.4
1975	268	99	36.9	214	53	24.8	17	11	64.7	499	163	32.7
1976	108	20	18.5	102	23	22.5	--	--	-----	210	43	20.5
1977	207	67	32.4	525	304	57.9	14	14	100.0	746	385	51.6
1978	420	296	70.5	1046	538	51.4	10	7	70.0	1476	841	57.0

Table 27. Atlantic cod catch per effort (metric tons per day fished) for USA tonnage class 2 (0-50 GRT) and tonnage class 3 (51-150 GRT) otter trawlers fishing in Southern New England (Subdivision 5Zw) and landing in New England ports. Data taken from trips for which 50% or more of the total landed weight consisted of cod during December-April (i.e., 1969 index derived from December 1968 and January-April 1969 data).

Year	Vessel Tonnage Class	
	Class 2	Class 3
1968[1]	3.1	4.1
1969	4.4	3.6
1970	3.3	5.1
1971	2.5	4.0
1972	2.0	2.2
1973	2.7	3.0
1974	2.1	3.2
1975	1.5	1.9
1976	1.7	1.6
1977	3.2	9.2 (3.9 excluding April data)
1978	5.1	3.3

[1] 1968 catch per effort indices derived from January-April data only. December 1967 data unavailable.

Table 28. Percentage, by market category, of USA commercial landings of Atlantic cod (metric tons, live weight) from Southern New England (Subdivision 5Zw) and the Middle Atlantic (Statistical Area 6), 1964-1978.

	Market Category				
Year	Large	Market	Scrod	Mixed	Total
1964	38	60	1	-	99
1965	47	52	1	-	100
1966	31	54	15	-	100
1967	18	67	13	1	99
1968	17	68	14	1	100
1969	17	77	5	-	99
1970	19	77	4	-	100
1971	23	73	4	-	100
1972	22	66	11	-	99
1973	9	43	47	-	99
1974	13	64	23	-	100
1975	20	73	7	-	100
1976	44	47	7	2	100
1977	24	29	46	1	100
1978	17	69	15	-	101

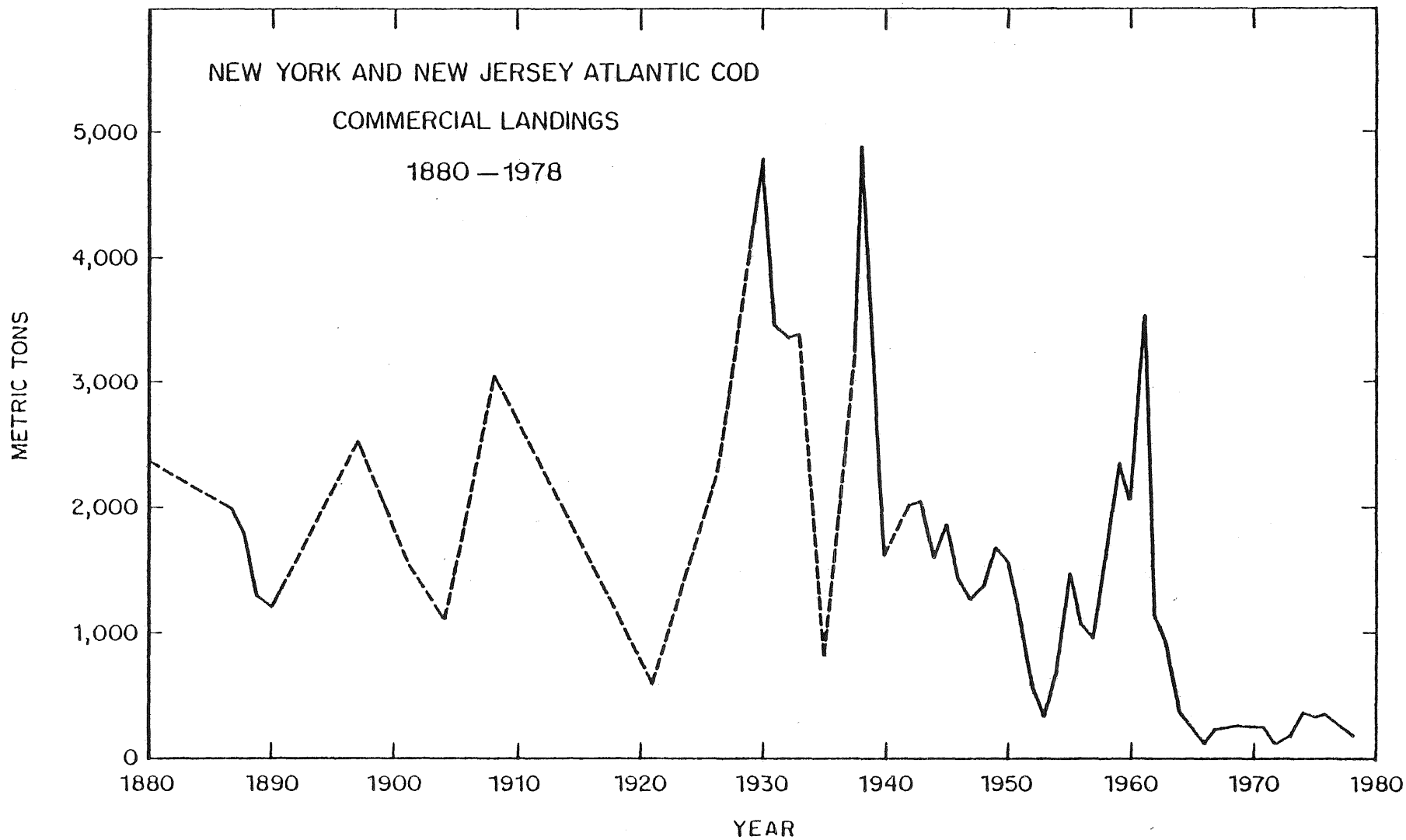


Figure 1. Annual commercial landings (metric tons, live) of Atlantic cod in New York and New Jersey, 1880-1978.

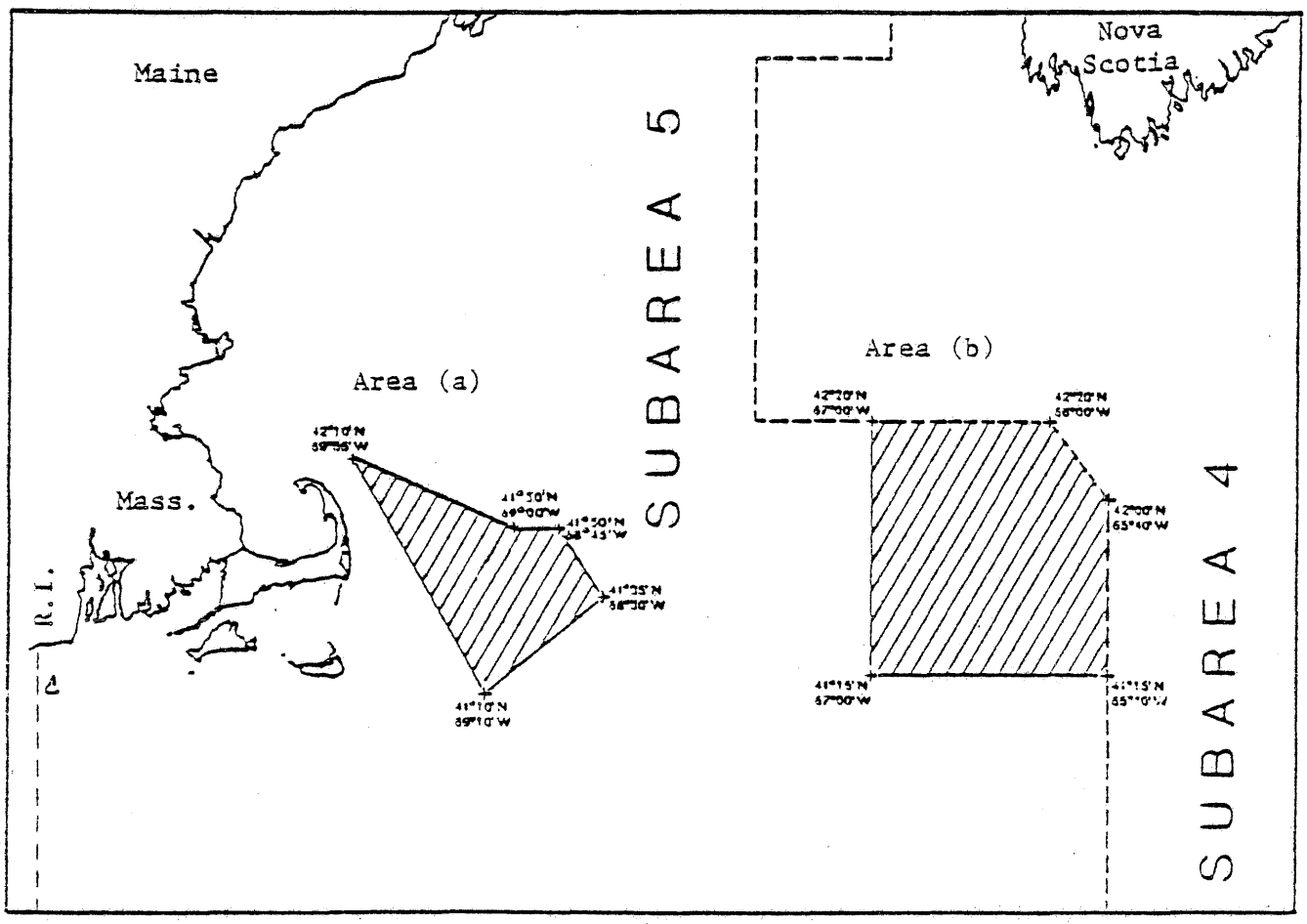
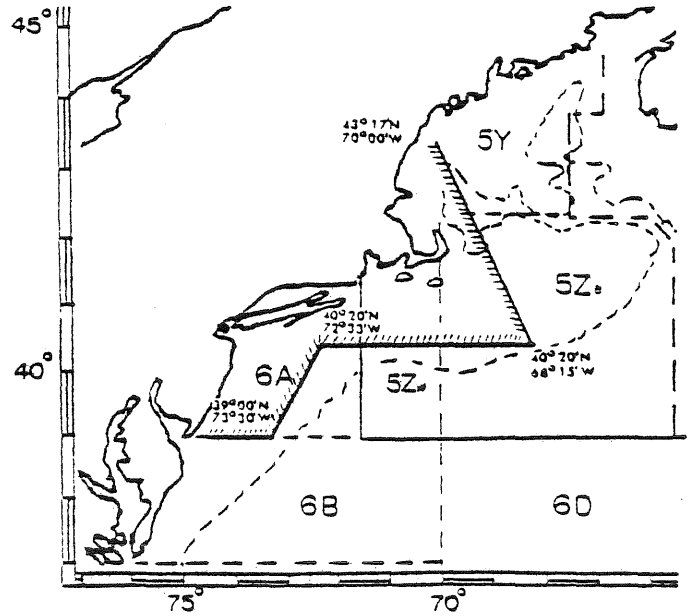


Figure 2. Principal haddock spawning areas on Georges Bank closed to gear capable of taking demersal species (crustacean and scallop gear and hooks with a gape of ≥3 cm excluded) during March, April, and May.

A



B

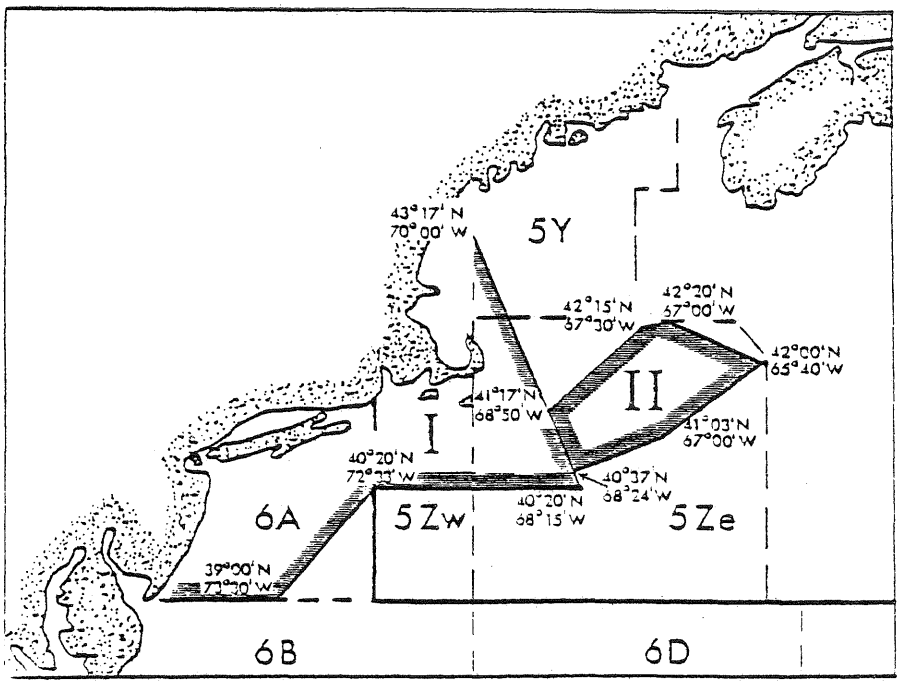


Figure 3. ICNAF areas closed to demersal fishing, other than for crustacea, by vessels over 130 feet (39.6 m) in length, (A) effective 1974 and (B) effective 1976.

A

B

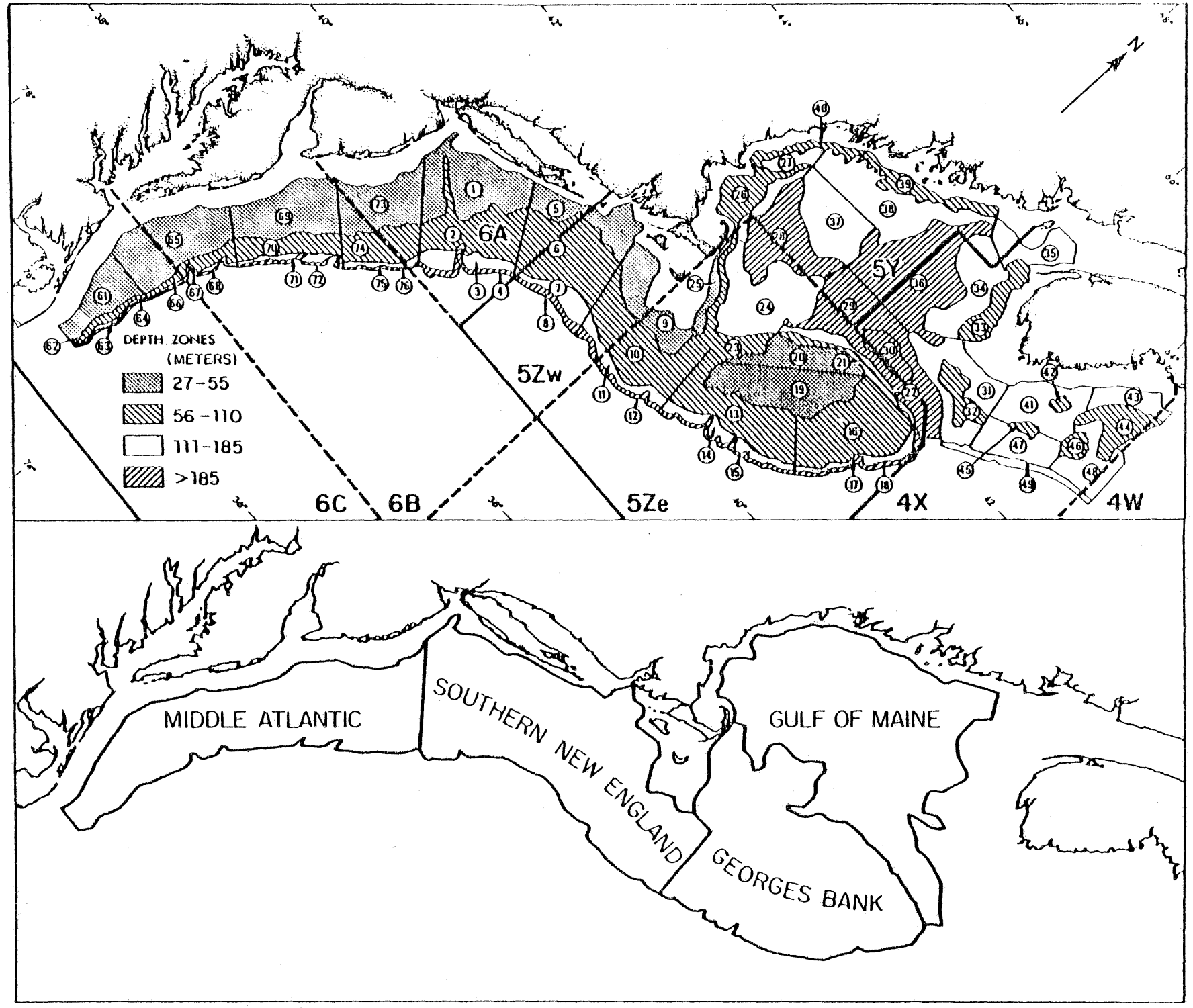


Fig. 4. Northwest Atlantic area from Nova Scotia to Cape Hatteras, a) delineated into strata by depth, with ICNAF division boundaries superimposed and b) delineated into major units for analytical purposes. (Source — Clark, S.H., and Brown, B.E. 1977.)

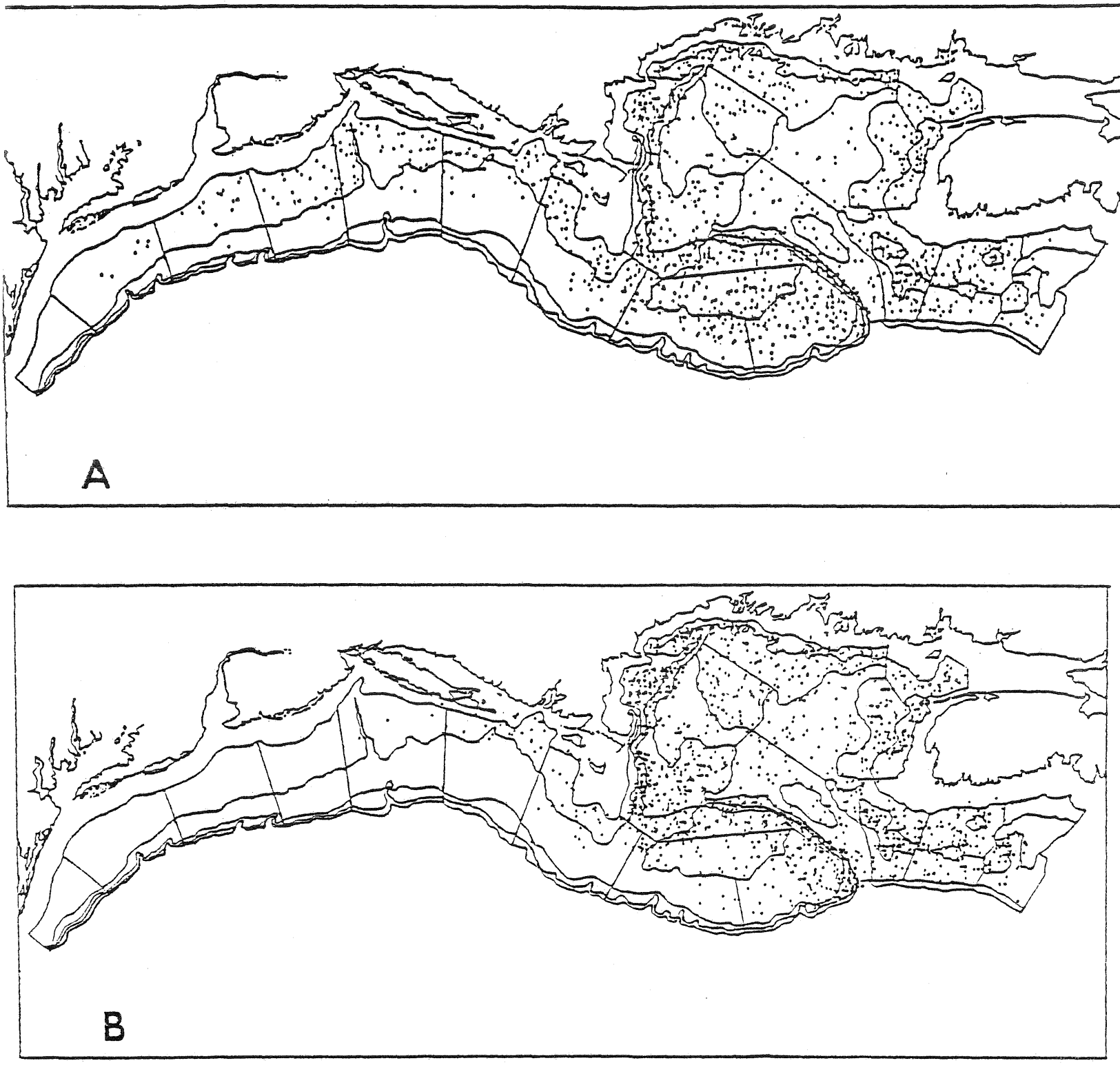


Figure 5. Cumulative station locations of Atlantic cod catches in NEFC offshore research vessel bottom trawl surveys conducted during spring, 1968-1978 (A), and during autumn, 1963-1978 (B). Sampling strata are superimposed on the Northwest Atlantic area from Nova Scotia to Cape Hatteras.

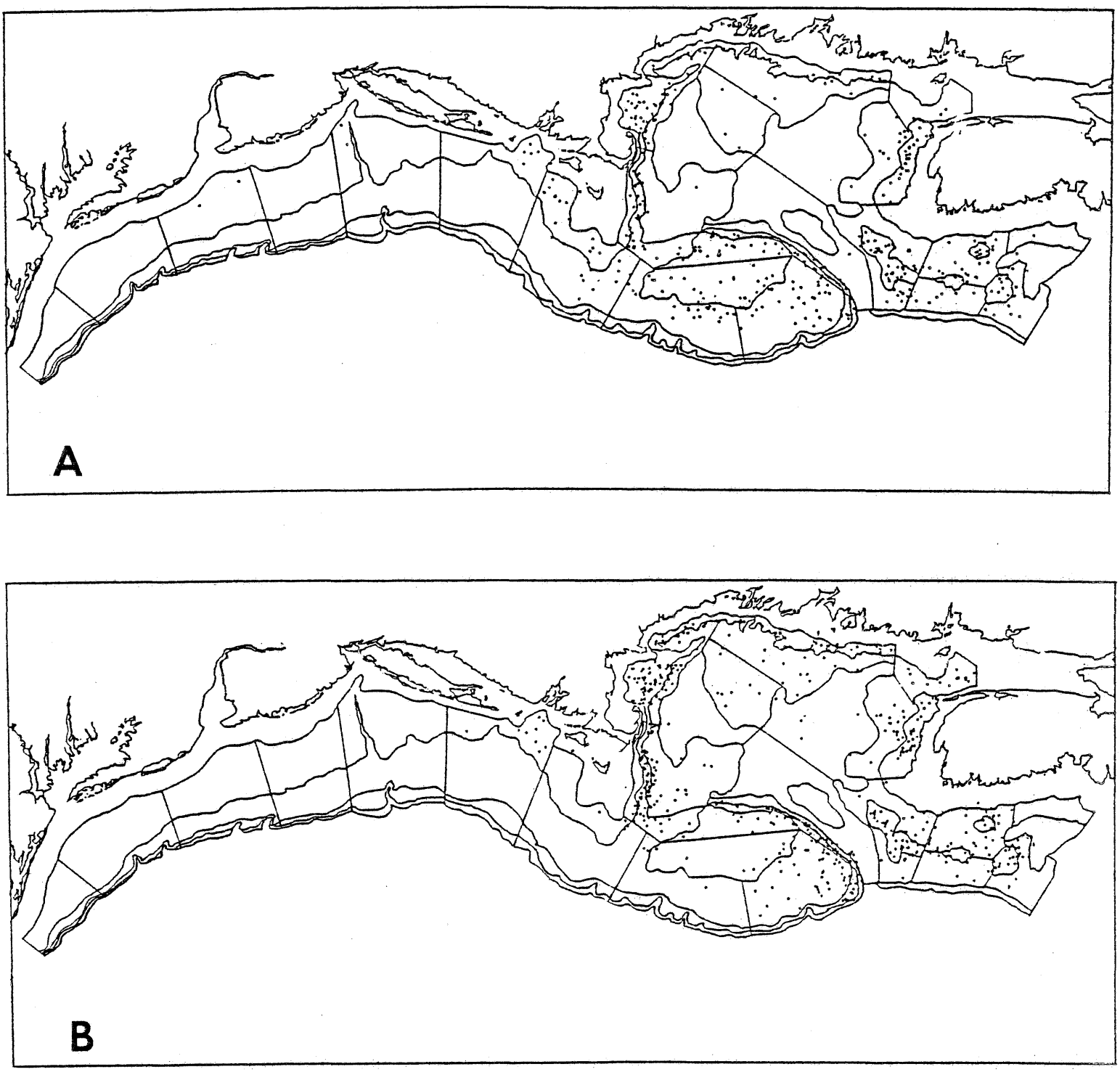


Figure 6. Cumulative station locations of juvenile Atlantic cod (<37 cm in length) catches in NEFC offshore research vessel bottom trawl surveys conducted during spring, 1968-1978 (A), and during autumn, 1963-1978 (B). Sampling strata are superimposed on the Northwest Atlantic area from Nova Scotia to Cape Hatteras.

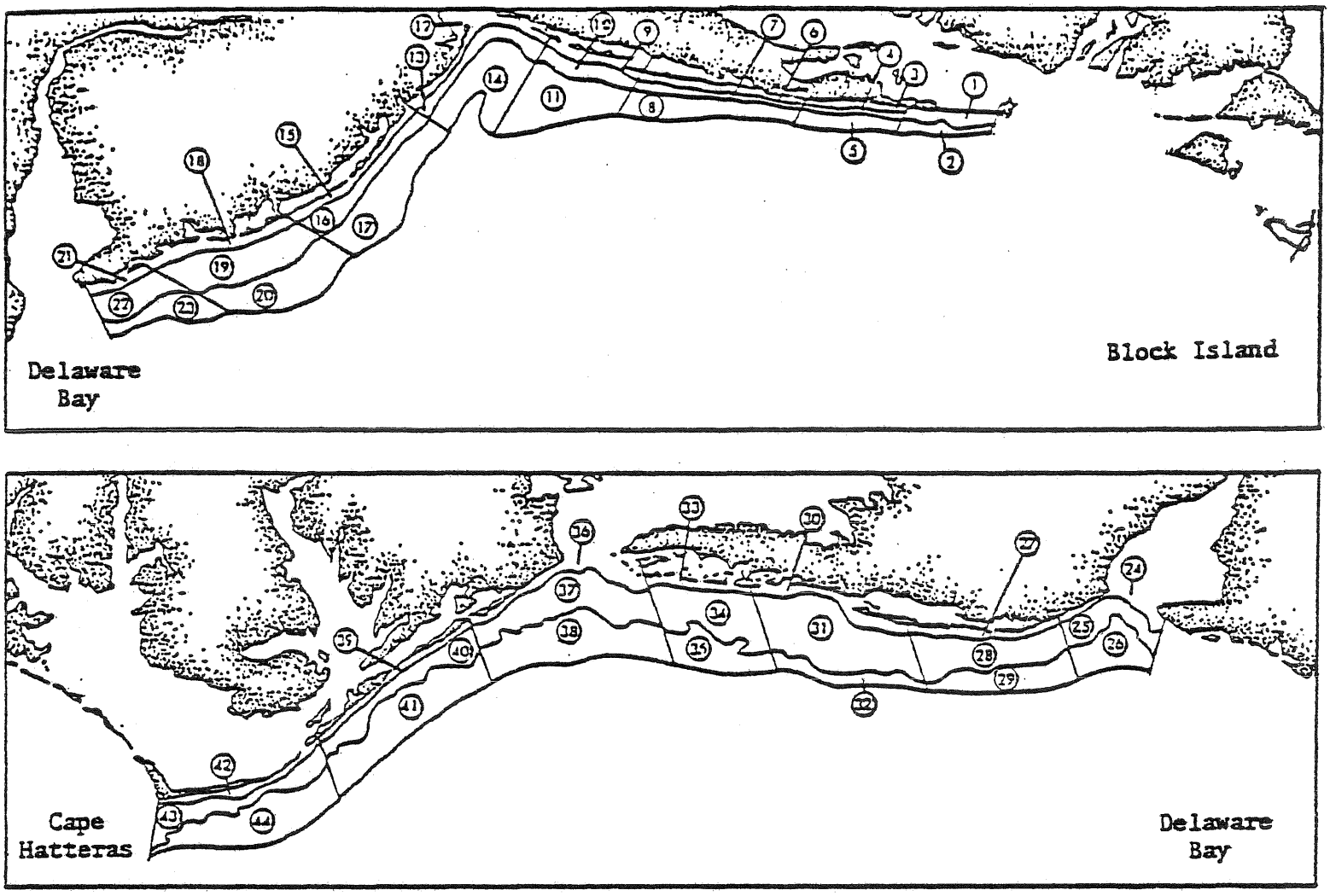


Figure 7. Northeast Fisheries Center (NEFC) inshore research bottom trawl survey strata (0-15 fm), Block Island to Cape Hatteras.

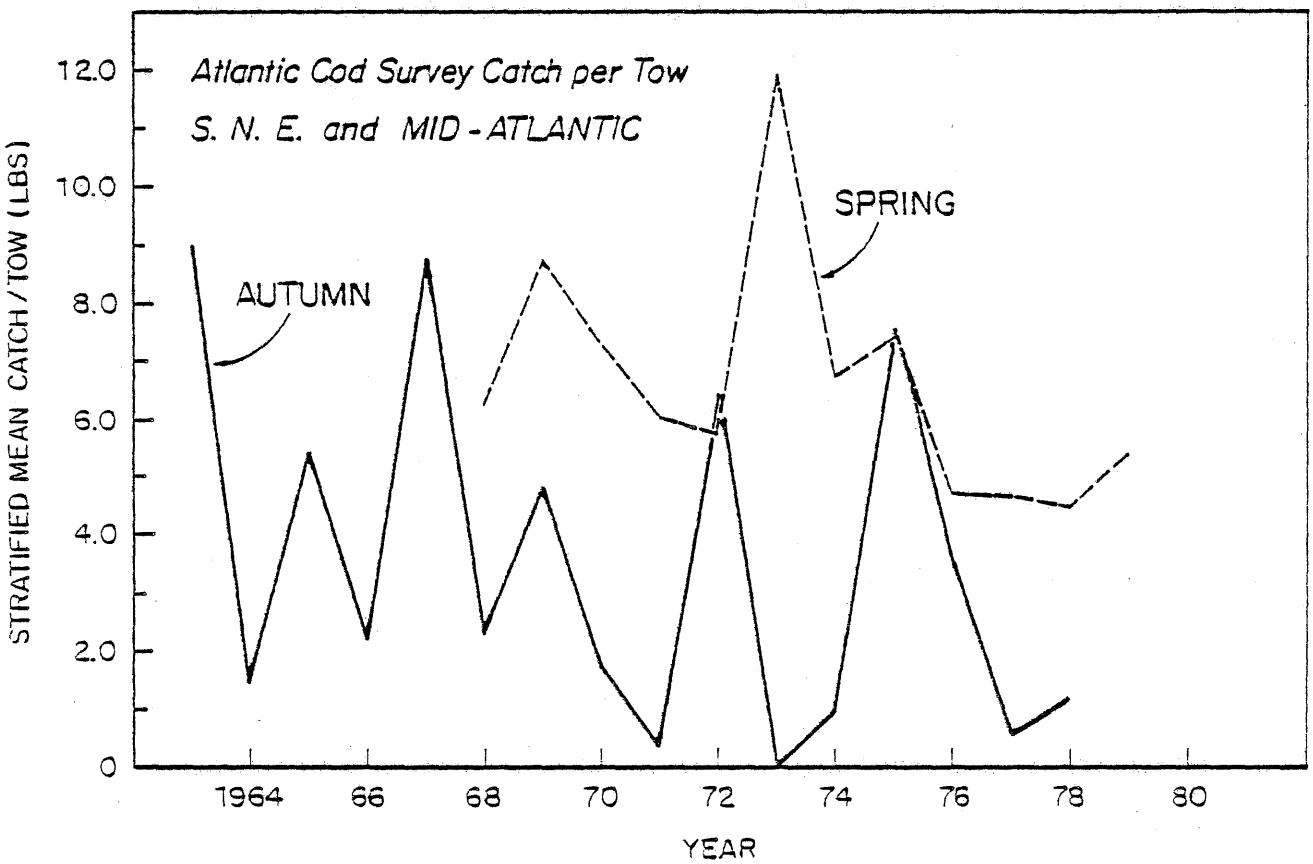


Figure 8. Stratified mean catch (pounds) per tow of Atlantic cod from NEFC spring (1968-1979) and autumn (1963-1978) offshore bottom trawl surveys in Southern New England and the Middle Atlantic (Spring: strata 1-2, 5-6, 9-10, 65, 69-70, and 73-74; Autumn: strata 1, 5, 6, 9, and 10). No adjustments have been made between spring data 1968-1972 and 1973-1979 for survey trawl size differences.

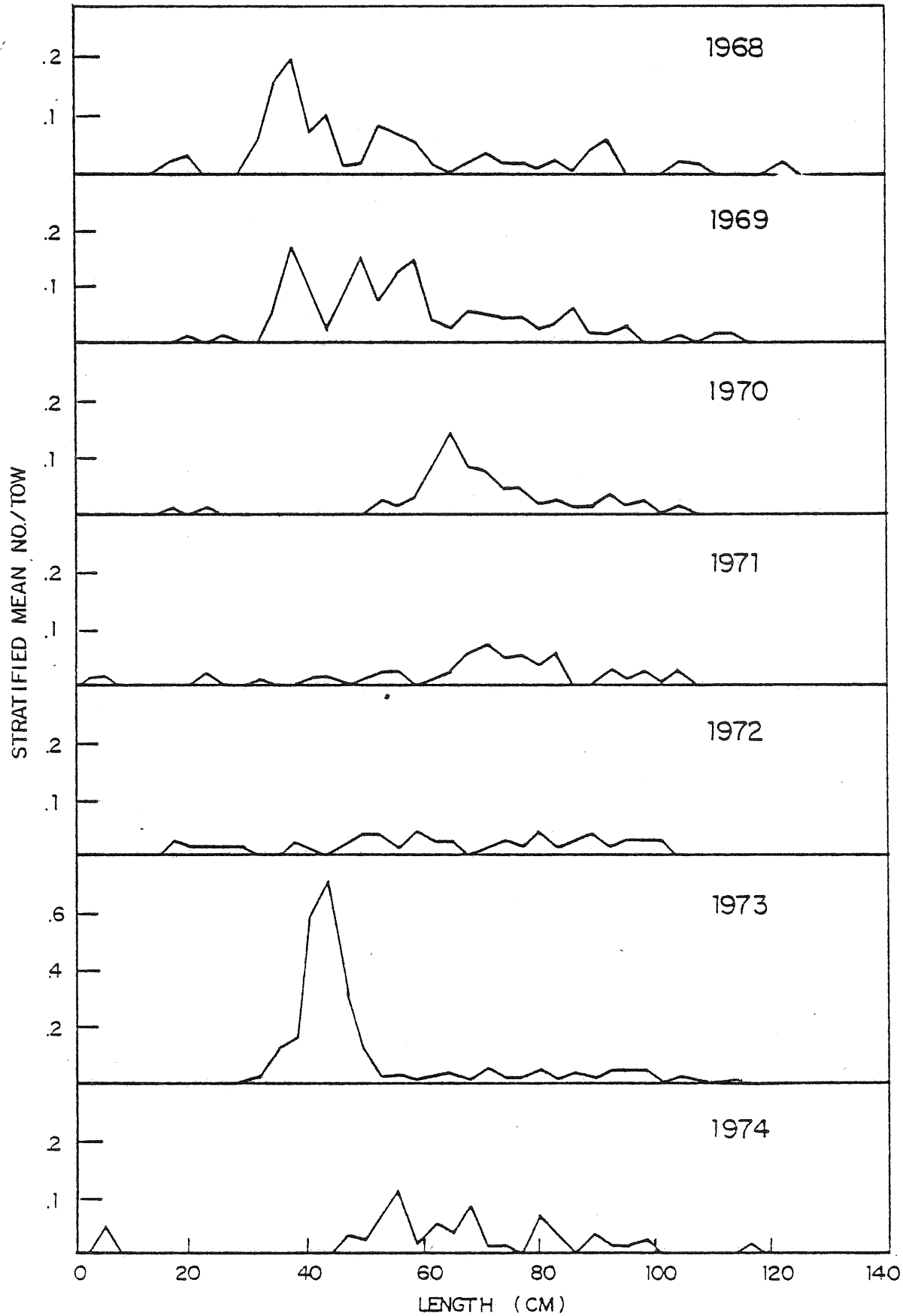


Figure 9. NEFC research vessel spring survey length-frequency distributions (stratified mean number per tow by 3-cm length category) of Atlantic cod from Southern New England and the Middle Atlantic (Strata 1-2, 5-6, 9-10, 65, 69-70 and 73-74), 1968-1978.

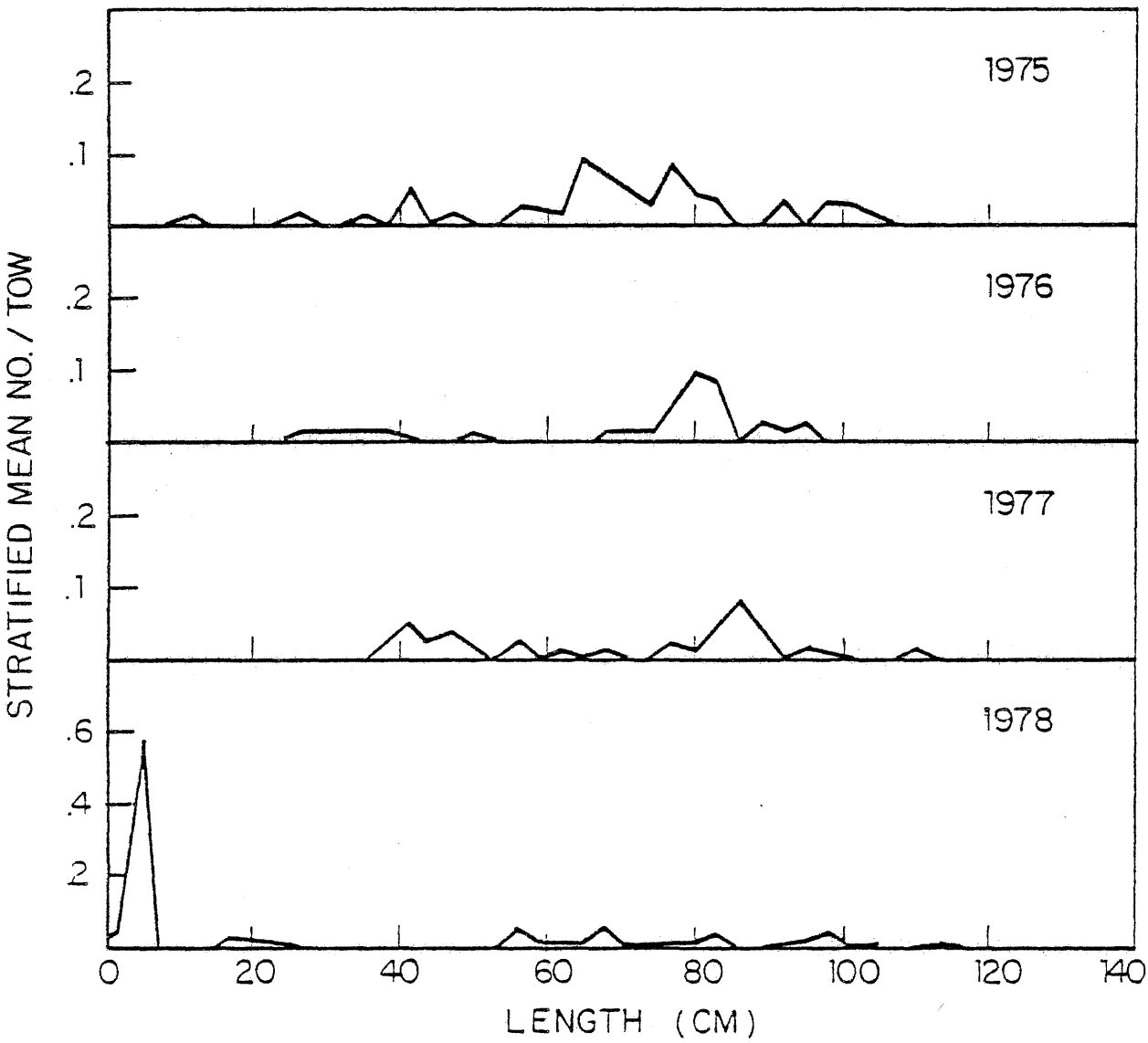


Figure 9. cont'd.

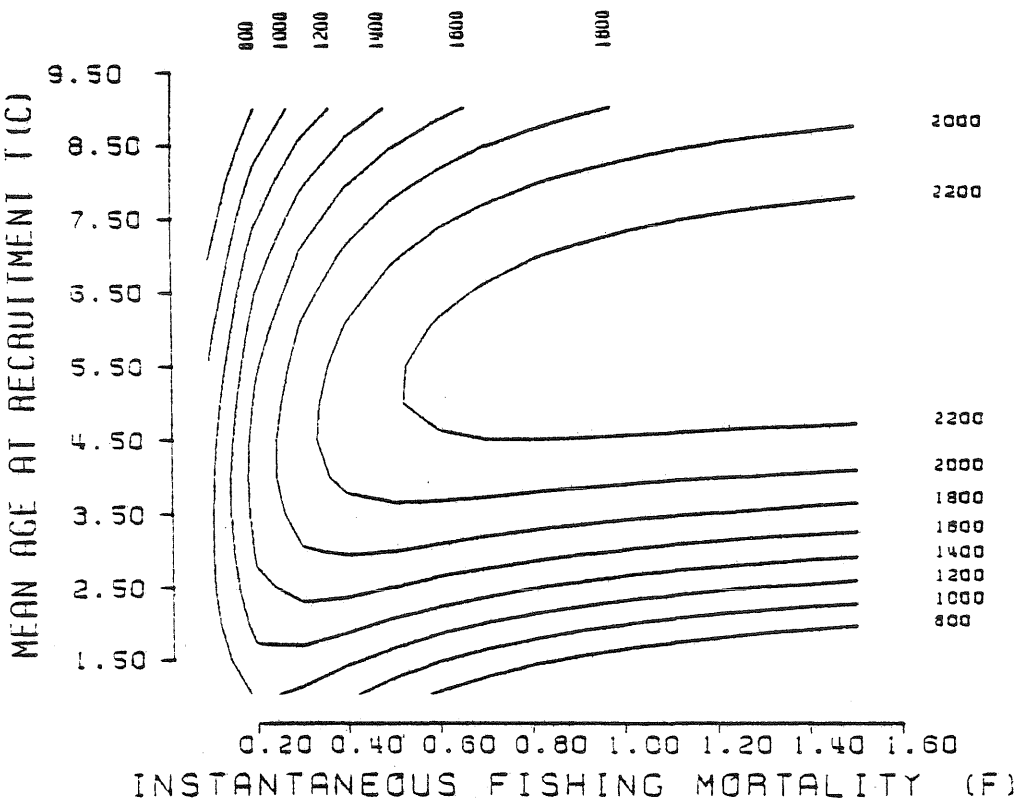


Figure 10. Yield isopleths (kg per 1,000 recruits) for Southern New England - Middle Atlantic cod assuming W_∞ = 14.92 kg, K = 0.257, t_o = 0.465, t_r = 1.0, t_λ = 12, and M = 0.2.

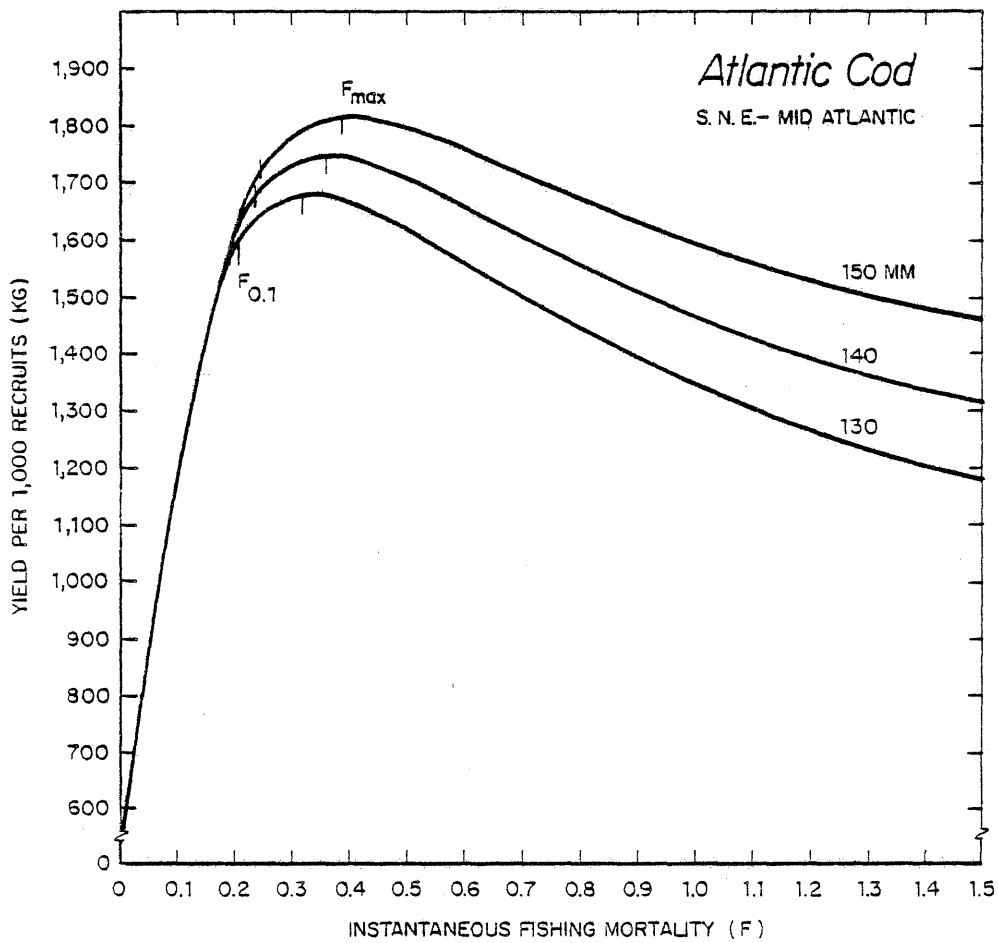


Figure 11. Yield per recruit curves for Southern New England-Middle Atlantic cod assuming otter trawl cod-end minimum stretched mesh sizes of 130, 140, and 150 mm. These values correspond to mean age at first capture values (t_c) of 2.55, 2.77, and 3.00 years, respectively. W_∞ = 14.92 kg, K = 0.257, t_o = 0.465, t_r = 1.0, t_λ = 12, and M = 0.2. F_{max} and $F_{0.1}$ are indicated for each curve.

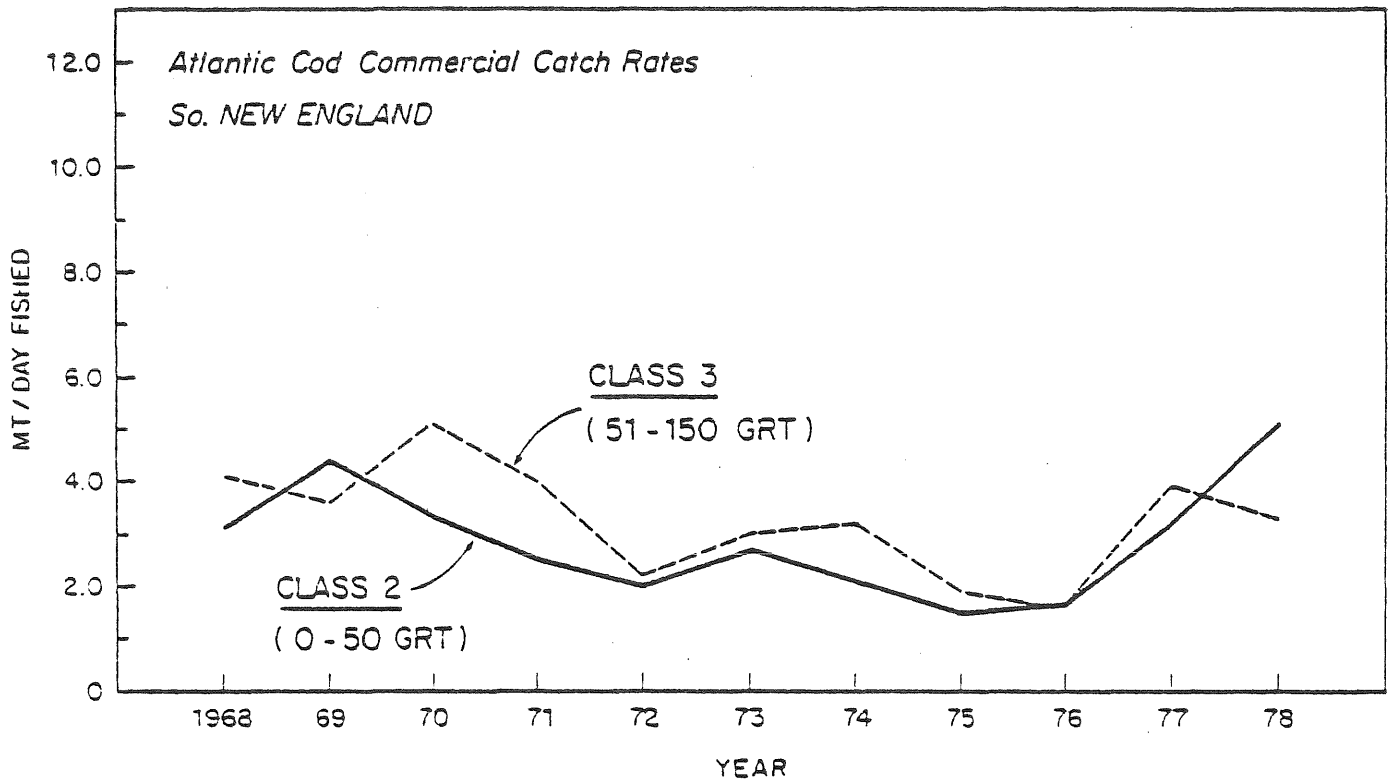


Figure 12. Atlantic cod catch notes (metric tons, live per day fished) for USA tonnage class 2 (0-50 GRT) and tonnage class 3 (51-150 GRT) otter trawlers fishing in Southern New England (Subdivision 5Zw) and landing in New England ports, 1968-1978. Data taken from trips for which 50% or more of the total landed weight consisted of cod during December-April (i.e., 1969 value derived from December 1968 and January-April 1969 data).