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AN ANALYSIS OF SPATIAL DIFFERENCES IN SIZE COMPOSITION AND ABUNDANCE OF BUTTERFISH, *Peprilus triacanthus*, OFF THE NORTHEAST UNITED STATES

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SUMMARY

Differential size distribution and abundance of butterfish, Peprilus triacanthus, in various areas off the northeast United States are reviewed in this document. The analysis compares the size distribution and abundance of butterfish in areas currently fished by domestic vessels in relation to other non-fished regions inhabited by butterfish,as determined from coastwide resource assessment surveys.

Geographical areas currently important in the domestic butterfish fishery were determined by plotting NEFC vessel interview data from Point Judith and Newport, Rhode Island, for the years 1982-1985. The majority of current USA butterfish landings are derived from a relatively small geographic area in Southern New England (SNE) waters. In recent years these vessels have expanded the fishery into deeper waters off SNE.

Size composition and abundance data for butterfish inhabiting five geographic sub-regions of the northeast coast were assessed from Northeast Fisheries Center (NEFC) inshore and offshore bottom trawl survey data. The five sub-regions were: (1) offshore, south of Hudson Canyon, (2) inshore, south of Delaware Bay, (3) inshore, north of Delaware Bay and offshore of Long Island, (4) Southern New England, and (5) Georges Bank. These relatively distinct sub-regions were identified based on consistency of patterns in size composition and abundance of butterfish over time.

Significant differences in the size composition of butterfish were apparent between the five geographic areas examined. Average sizes of butterfish in the SNE area (currently accounting for the predominance of landings) are generally intermediate between subareas to the south and west (occupied by smaller butterfish) and areas to the north and east (inhabited by

larger fish). However, average butterfish abundance (numbers and weight per standardized survey tow) has been greatest off SNE since 1980. This spatial distribution by size groups confirms earlier work by Anderson and Waring (1981).

INTRODUCTION

Atlantic butterfish (*Peprilus triacanthus*) occur along the east coast of North America from Newfoundland to Florida (Hildebrand and Schroeder 1928), and are commercially important between Cape Hatteras and Southern New England. The stock north of Cape Hatteras migrates inshore and northward during the summer and offshore and southward to the edge of the continental shelf in late autumn where overwintering occurs (Murawski and Waring 1979).

Butterfish were exploited exclusively by the domestic fishermen from 1920-1962. Distant-water-fleets (DWF), initially from the USSR, began exploiting butterfish in 1963. Butterfish landings peaked at 19,500 metric tons (mt) in 1973, with over 90% taken by the DWF primarily as a by-catch in squid (*Loligo* and *Illex*) fisheries. However, since implementation of the Magnuson Fishery Conservation and Management Act in 1977, the fishery has again been prosecuted principally by domestic fishermen.

High abundance of small butterfish and low availability of marketable fish have beset the domestic fishery on the preferred (SNE) fishing grounds (USDC 1985) since the summer of 1983. In response to this abundance of small fish and a strong export market, a new "supersmall" market category was established. However, since a large portion of the catch was below the size to be considered "supersmall", they were discarded heavily. Very high discard rates (30-100%) were observed by NMFS port agents during mid-1983-85. Continued high abundance of small butterfish, coupled with a weak "supersmall"

market in 1985, encouraged some fishermen to convert their vessels to freezer/trawlers and to install culling machines. These machines are intended to size grade marketable fish, and separate out sub-marketable size fish for discard at sea. This new technology purportedly allows vessels to profitably fish in areas of high abundance of small butterfish, despite reportedly high discard rates (in excess of 50% of vessel catch).

This document describes size distribution and abundance of butterfish off the northeast USA coast, particularly in reference to the important commercial fishing grounds, based on research vessel survey data. If, in fact, size segregation of butterfish occurs, and densities of larger fish are high enough to support fishing, then discarding could be minimized by changing the areal distribution of fishing to correspond with larger-sized butterfish.

Commercial Fishing Areas

Pt. Judith and Newport, Rhode Island butterfish catches for 1982-1984 and January-March 1985 were plotted by 10-minute blocks to determine important domestic fishing grounds. These years represent a period of increased domestic effort for the two most important butterfish ports; these two ports accounted for 80% of total butterfish landed in 1982-84. It is evident that most of the catches were taken in a relatively small geographic region (Figures 1-4), which corresponds to statistical reporting Areas 526, 537, and (50 fathom) curve, have become increasingly important in recent years. These extended fishing grounds seem to indicate a spatially expanding butterfish fishery.

Size Composition

Butterfish length frequency data from the 1983-1984 autumn and the 1984-1985 spring NEFC bottom trawl surveys (Grosslein 1969) were examined for size/spatial differences, particularly in reference to the important fishing areas noted above. These surveys were selected since they represent the most recent years for which consecutive autumn/spring bottom trawl survey data are available. Based on these examinations, survey data are portioned into five geographic regions (Figures 6-8 , Table 1).

Autumn 1983 and 1984 length frequency distributions (numbers per mille) are shown in Figure 9. Size distributions in 1983 in the offshore (>27 m) strata south of Hudson Canyon, inshore strata (<27 m) south of Delaware Bay, and inshore north of Delaware Bay and offshore south of Long Island, were characterized by a strong mode at 10-11 cm. Whereas, in 1984 the modes in these three regions were at 11-13, 9-12, and 7-8 cm, respectively. Also, most of the fish in the inshore strata north of Delaware Bay and offshore Long Island were $\leq$10 cm. Size composition in the 1984 SNE and 1983-1984 Georges Bank (GB) strata sets was generally larger than that observed in the first three regions. Further, in 1984 SNE and GB length frequency distributions with the mode at 16-18 cm were similar.

Since spring surveys occur when butterfish are distributed primarily offshore near the edge of the continental shelf (Murawski and Waring 1979), only, the SNE and offshore south of Hudson Canyon strata sets were used (Figure 6). Spring 1984 and 1985 length frequency distributions are shown in Figure 10. In 1984, the size range (9-21 cm) in waters south of Hudson Canyon was slightly greater than the range (10-19 cm) observed in the SNE regions and catches of fish >13 cm were higher in the former area. Whereas, in 1985 the

size compositions were similar in both regions. And although 1984 and 1985 size composition data were characterized by a strong mode at 11-12 cm, catches of large fish (≥15 cm) declined in 1985.

In addition to NEFC survey data, the size composition of butterfish collected on GB and in SNE waters in October-November 1985 by the Polish R/V WIECZNO were compared (Figure 11). These data indicate that in autumn 1985, butterfish on GB were significantly larger than in SNE waters (similar to the 1983 pattern for NEFC trawl surveys).

Survey Abundance Indices

Indices of relative abundance and biomass (number and weight) and mean weight per fish derived from NEFC 1968-1985 spring and autumn bottom trawl surveys were examined to compare trends among the geographic regions.

Autumn indices were determined for the SNE and GB strata sets (Figure 6), and the combined inshore/offshore strata sets presently used to monitor the annual trends in survey abundance indices (Waring and Anderson 1983). Trends in autumn catch per tow indices (number and weight), for all three strata sets, are similar for the entire 18-year (1968-1985) time series (Figure 12) Values were generally lower from 1968-1978 than from 1979-1985 (during earlier period total international fishing effort was very much greater than effort levels in the latter period). Indices of abundance based on the combined inshore/offshore data set indicated the same general trends in stock size over the study period, but were less subject to wide interannual changes in the indices, than were indices for the SNE area individually. Thus these data indicate that indices based on the combined inshore/offshore strata are more conservative criteria for monitoring annual changes in stock abundance than values determined for the SNE region alone.

Trends in autumn mean weights indicate that in most years larger fish were caught on GB (Figure 13). The sharp declines in GB mean weights in 1977, 1978, 1979, and 1985, are attributable to some large catches of very small (<8 cm) fish.

Spring indices were determined for the SNE and offshore south of Hudson Canyon strata sets (generally few butterfish occur in nearshore areas during the spring surveyperiod due to low temperatures. The trends in the 1968-1985 abundance indices (number and weight) and mean weights were similar for the entire time period (Figure 14). The 1973-1981 indices (weight) were adjusted downwards by a factor of 0.74 to account for the larger survey net used (#41 trawl; Sissenwine and Bowman 1978). In general, spring data exhibit more variability and a less distinct trend over time than do autumn data. This may result from variability in the distribution of butterfish relative to the continental shelf break in various years, rendering a portion of the resource beyond the geographical boundaries of the bottom trawl survey in spring.

DISCUSSION

The important USA butterfish fishing grounds encompass a relatively small portion of the species range. Several contributing factors are abundance, geographic proximity of markets, and the economics of catching and processing. As indicated in NEFC survey data, butterfish abundance is highest in SNE (important fishing grounds) region. Therefore, it should be expected that most of the fishing occurs in that region. Also, since the domestic market is principally for fresh fish and the Japanese export market demands high quality fish, traditional otter trawl butterfish vessels must make short (1-2 day) trips to ensure a quality product. Therefore, it would probably be

uneconomical for Pt. Judith and Newport, Rhode Island vessels to fish in areas which require significantly greater transit times. However, the recent introduction of freezer/trawlers into the fishery may result in a spatial extension of the fishing grounds.

The size/spatial segregation observed in 1983 and 1984 autumn survey data indicate that smaller fish <10 cm are dominant in inshore waters north of Delaware Bay and probably represent summer-spawned fish. In the inshore waters south of Delaware Bay and generally in the offshore waters, butterfish encompassing the entire size range were encountered, but fish ≥10 cm predominate. Size composition and mean weight data for GB are generally greater than similar biological parameters obtained for the SNE region. In 14 of the 18 years examined (78%) butterfish mean weights for fall bottom trawl surveys were greater on Georges Bank than in Southern New England waters (Figure 10). However, the abundance indices (numbers and weight) for GB are generally lower than values derived for SNE strata, which may suggest that in the former region commercial quantities are limited. But, since approximately 50% of the SNE catch is discarded, the lower densities of principally larger fish on GB should allow for profitable fishing in this region. Nevertheless, in the late 1960's and early 1970's, the DWF's harvested butterfish on GB (Waring 1975).

Based on the 1984 and 1985 spring survey data, butterfish size classes are mixed in the offshore SNE and south of Hudson Canyon waters. This is attributed to the offshore migration which they undertake in response to seasonal cooling of nearshore waters (Murawski and Waring 1979). Spring abundance indices and average weights were generally highest in the SNE region, where most of the fishing is conducted.

Increased interest in the harvesting of butterfish by domestic fishermen is expected to continue due to increasing export markets, processing capacity, and joint venture opportunities. Expansion of the fishery may require fishermen to exploit butterfish throughout its entire offshore range, particularly in summer and autumn when stratification by size is most apparent. Based on the information contained in this document and earlier work by Waring and Anderson (1981), marketable butterfish are consistently taken in surveys beyond the geographical bounds of the heretofore important fishing grounds of Southern New England.

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Table 1. Geographic regions and the corresponding NEFC bottom trawl survey sampling strata used in the analysis of NEFC research vessel butterfish catches.

Region	Strata
1. Offshore, south of Hudson Canyon	61-76 offshore
2. Inshore, south of Delaware Bay	24-44 inshore
3. Inshore north of Delaware Bay and offshore Long Island	1-23, 45, 46 inshore 1, 5 offshore
4. Southern New England	3, 6, 7, 10, 11 offshore
5. Georges Bank	13,14,19,20,23,25 offshore

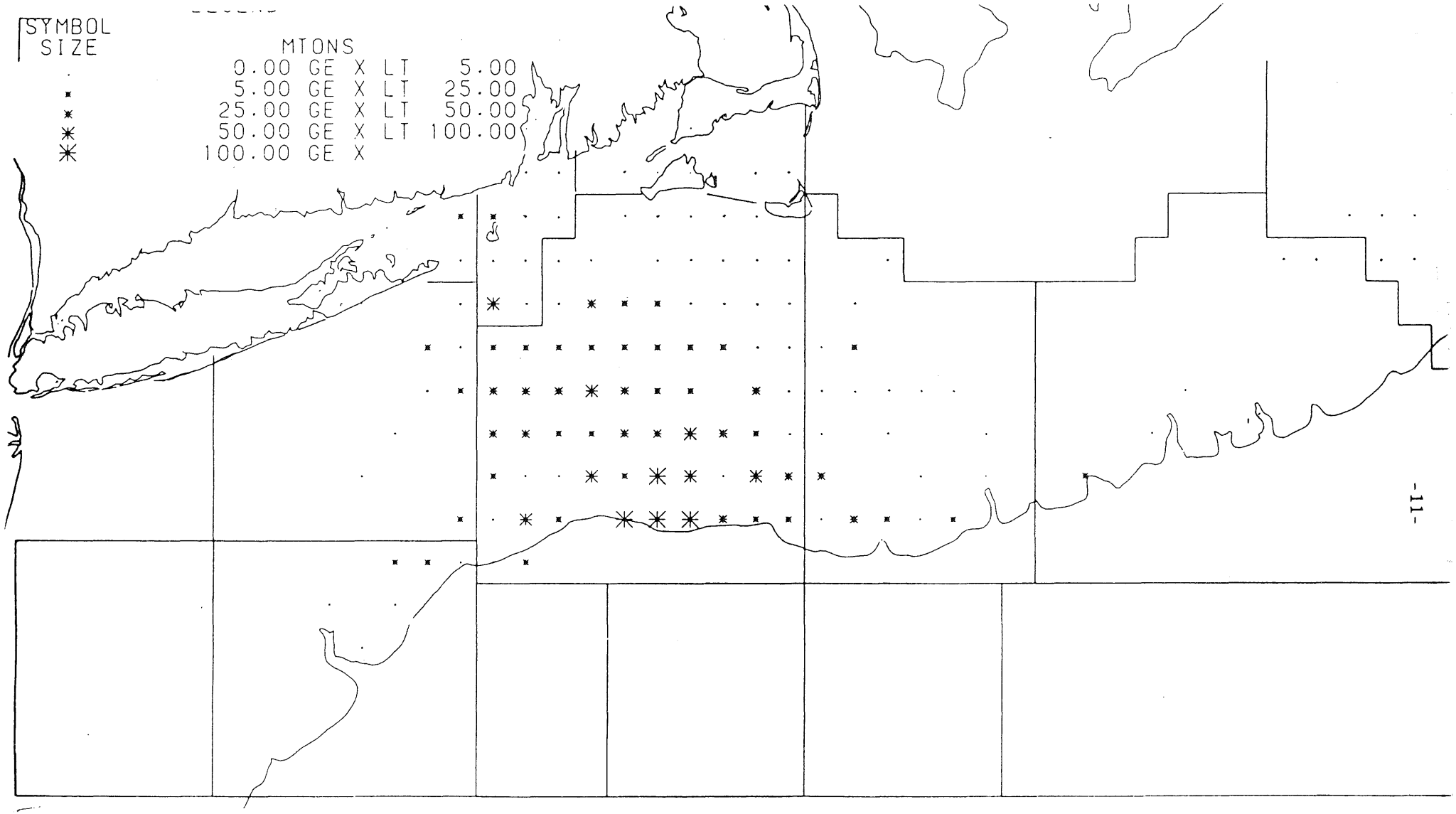


Figure 1. Distribution of 1982 butterfish catches by 10 minute squares based on interview data for the ports of Pt. Judith and Newport, Rhode Island, and New Bedford, Massachusetts.

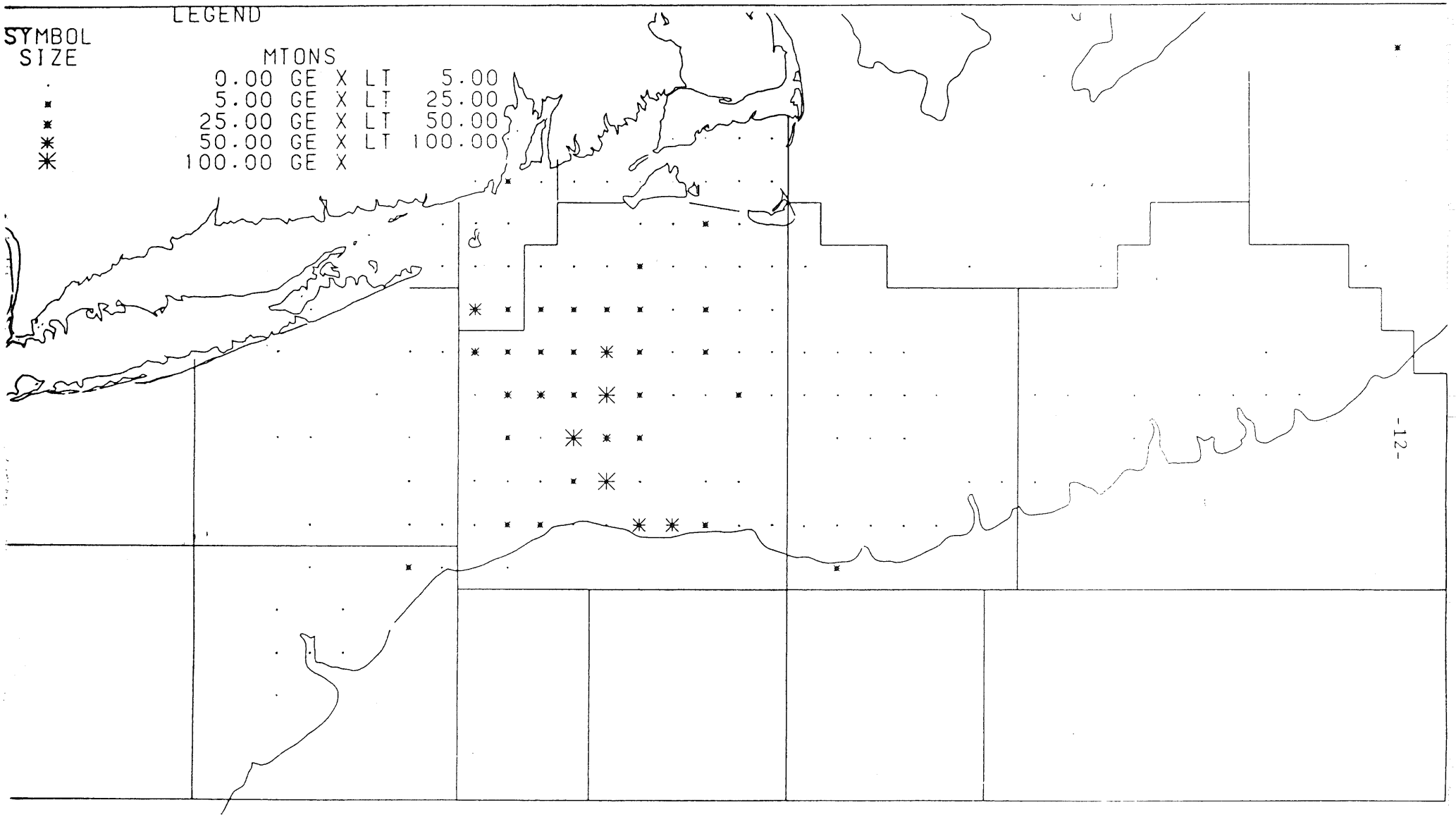


Figure 2. Distribution of 1983 butterfish catches by 10 minute squares, based on interview data for the ports of Pt. Judith and Newport, Rhode Island, and New Bedford, Massachusetts.

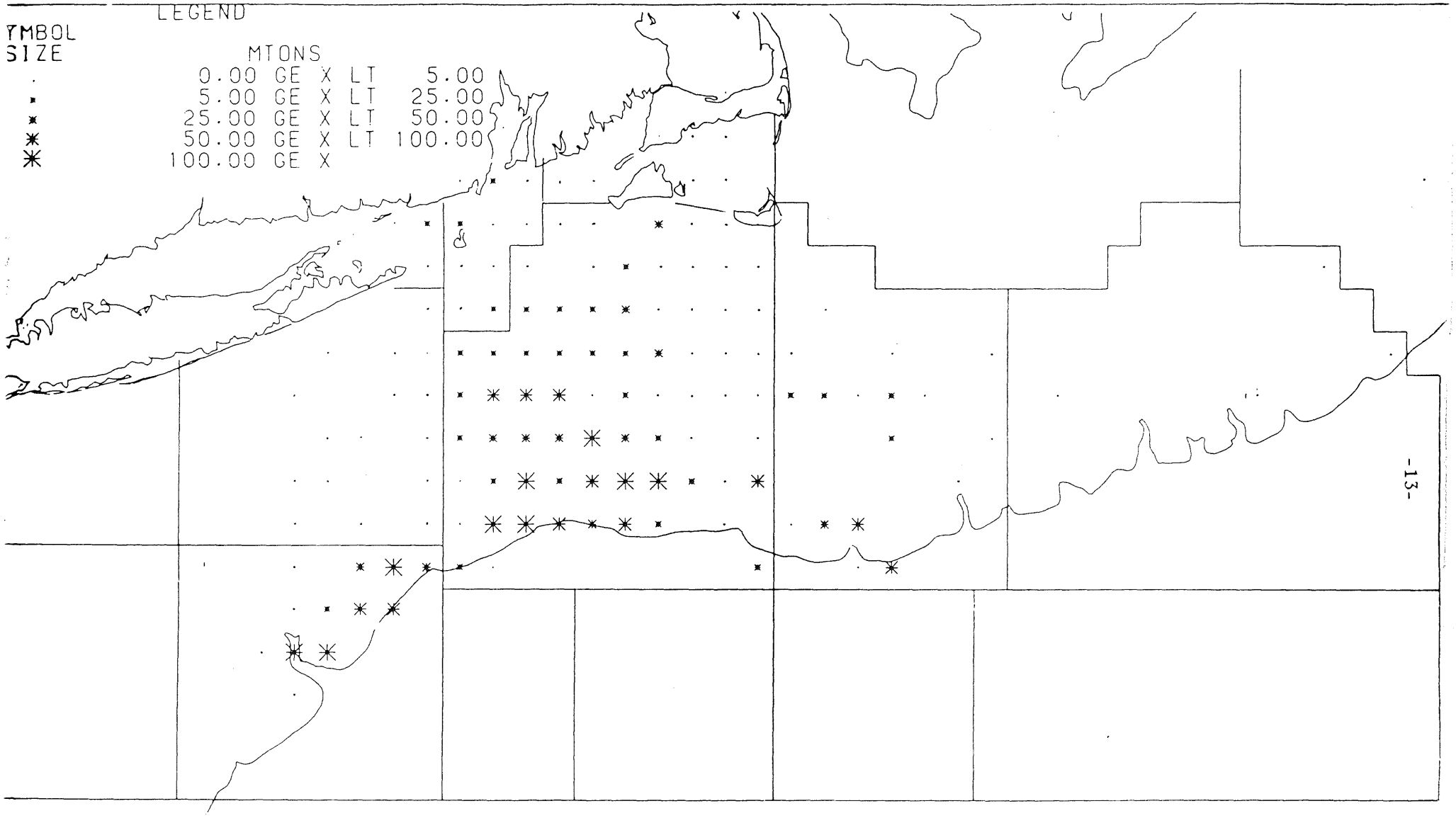


Figure 3. Distribution of 1984 butterfish catches by 10 minute squares, based on interview data for the ports of Pt. Judith and Newport, Rhode Island, and New Bedford, Massachusetts.

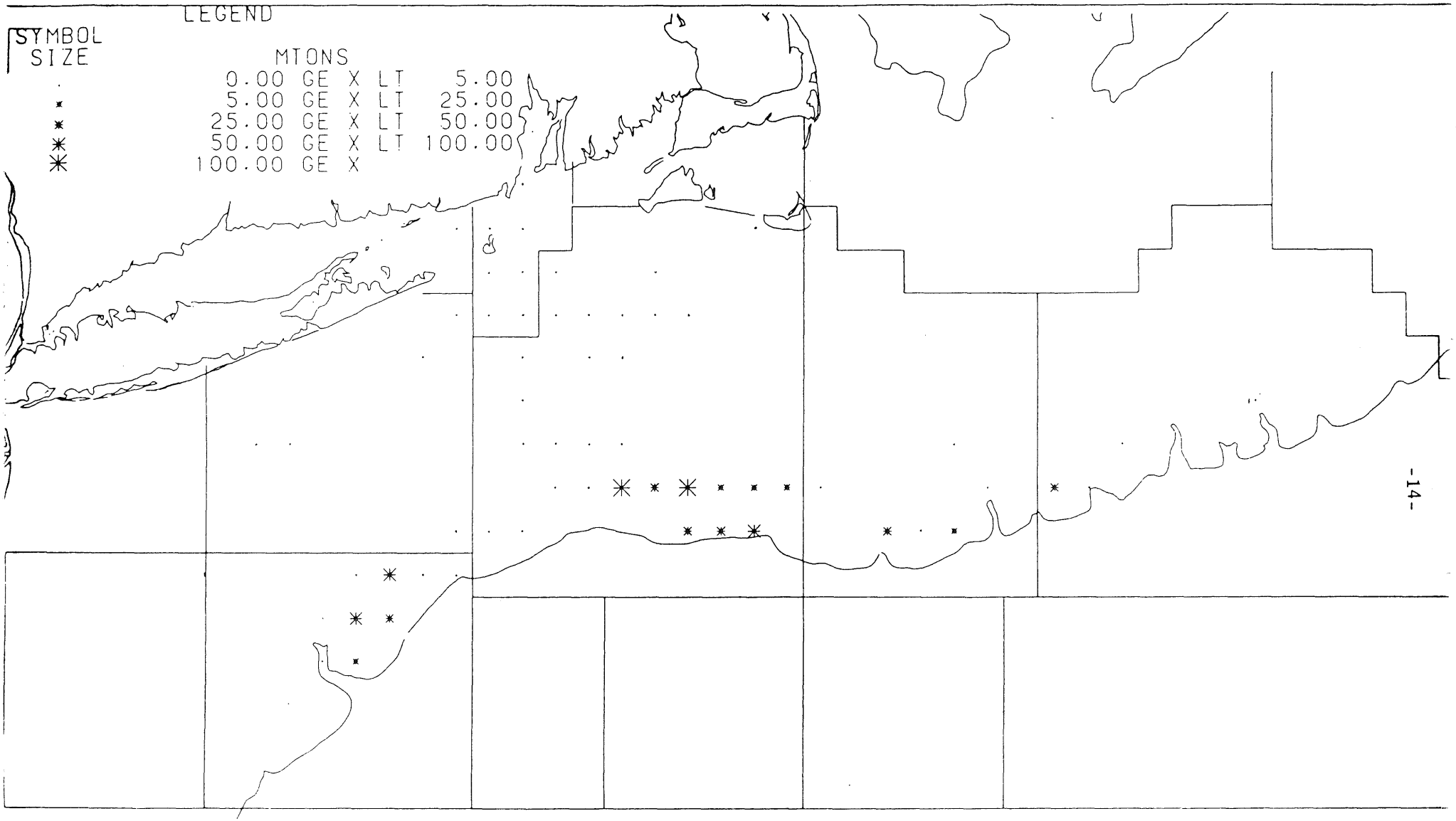


Figure 4. Distribution of January-March 1985 butterfish catches by 10 minute squares, based on interview data for the ports of Pt. Judith and Newport, Rhode Island, and New Bedford, Massachusetts.

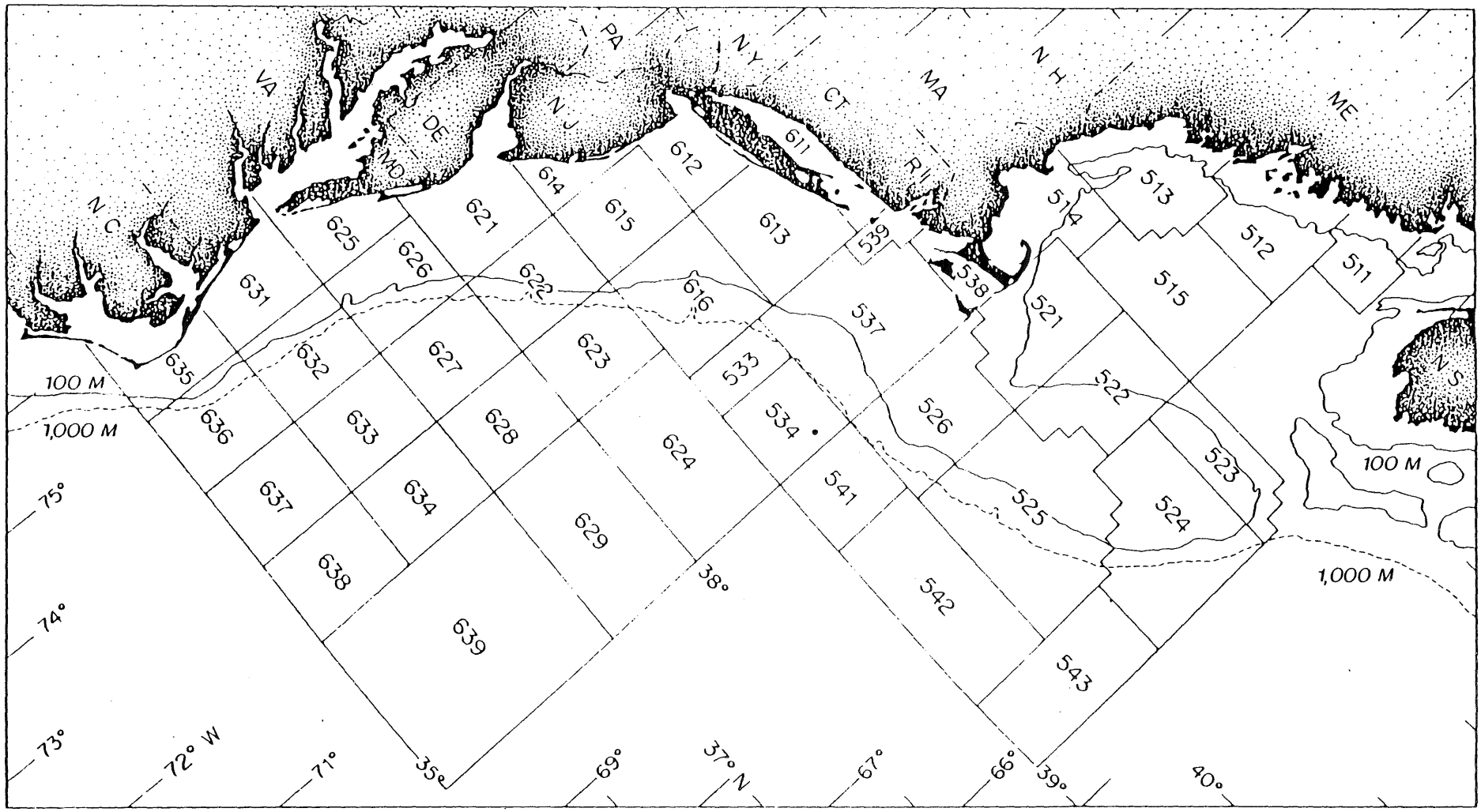


Figure 5. Northeast Region reporting areas for commercial fishery statistics.

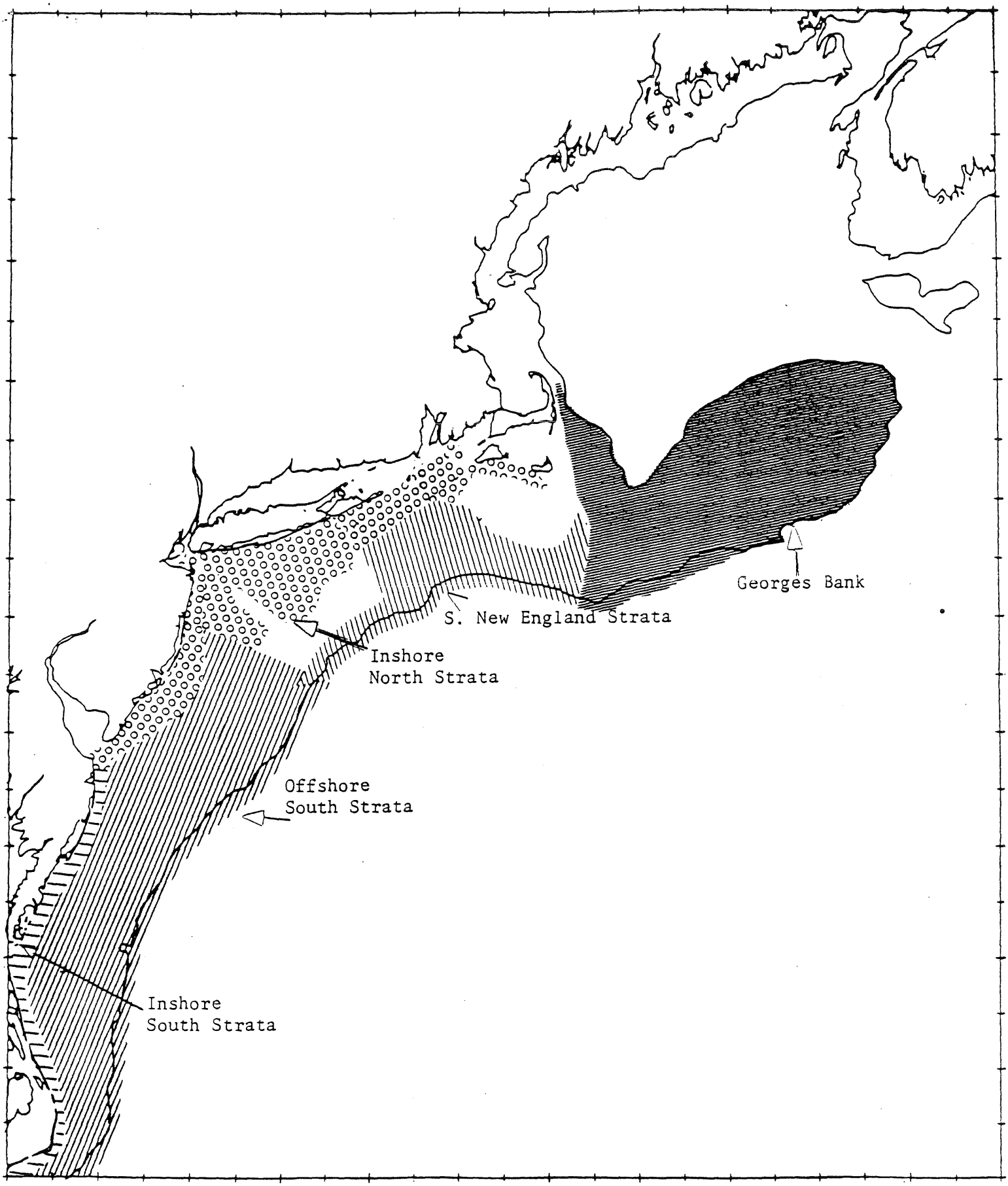


Figure 6. Shaded areas correspond to the five geographic regions used in the analysis of butterfish catches taken in 1983-85 NMFS/NEFC autumn bottom trawl surveys.

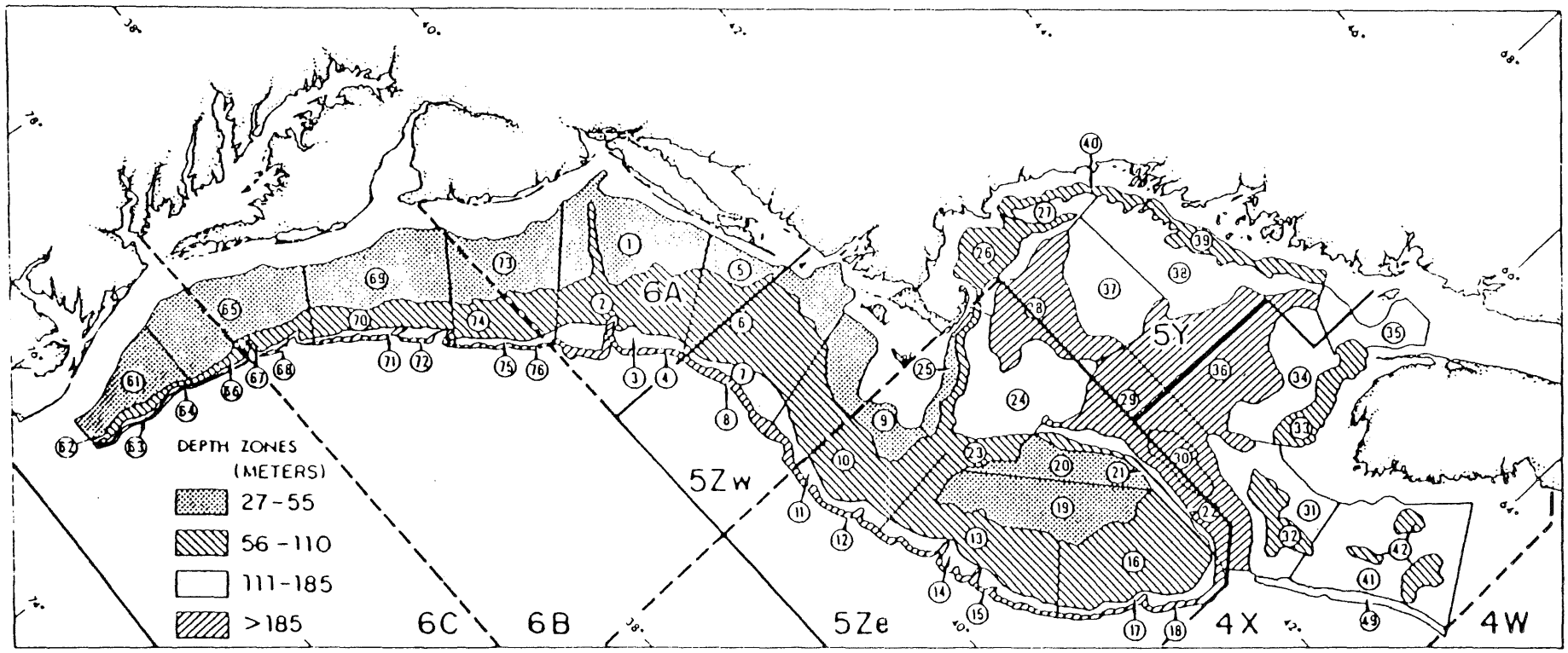
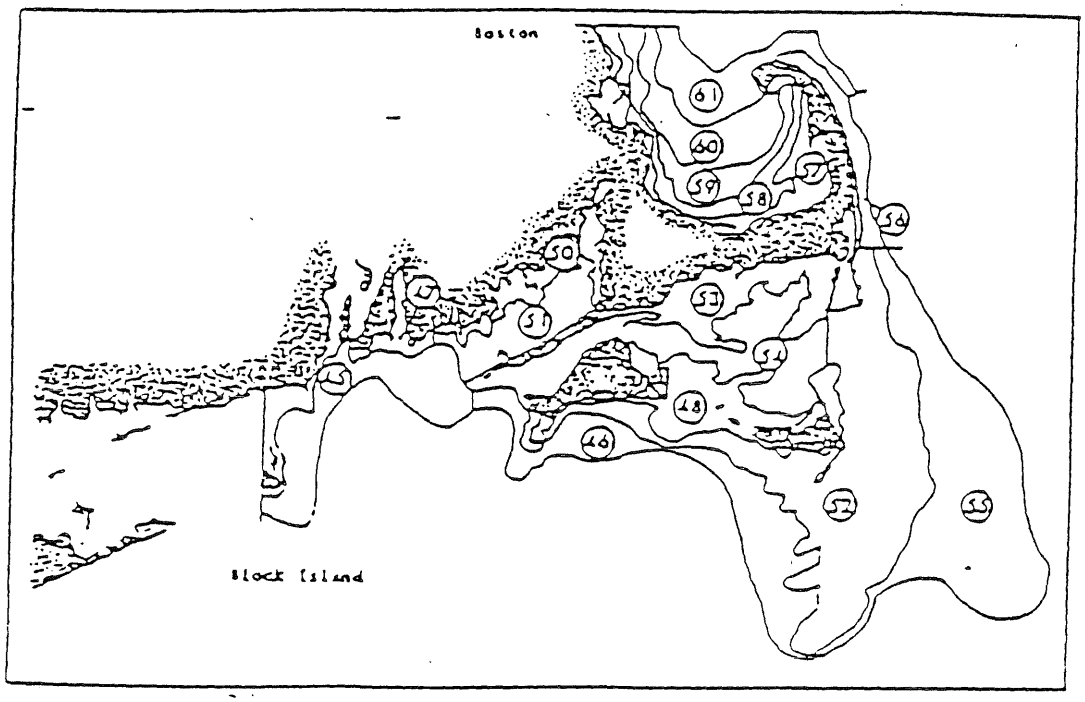


Figure 7. Northeast Fisheries Center research vessel offshore (>27 m) sampling strata, and NAFO statistical reporting areas.

COASTAL STRATA

BLOCK ISLAND TO BOSTON



COASTAL STRATA

CAPE HATTERAS TO BLOCK ISLAND

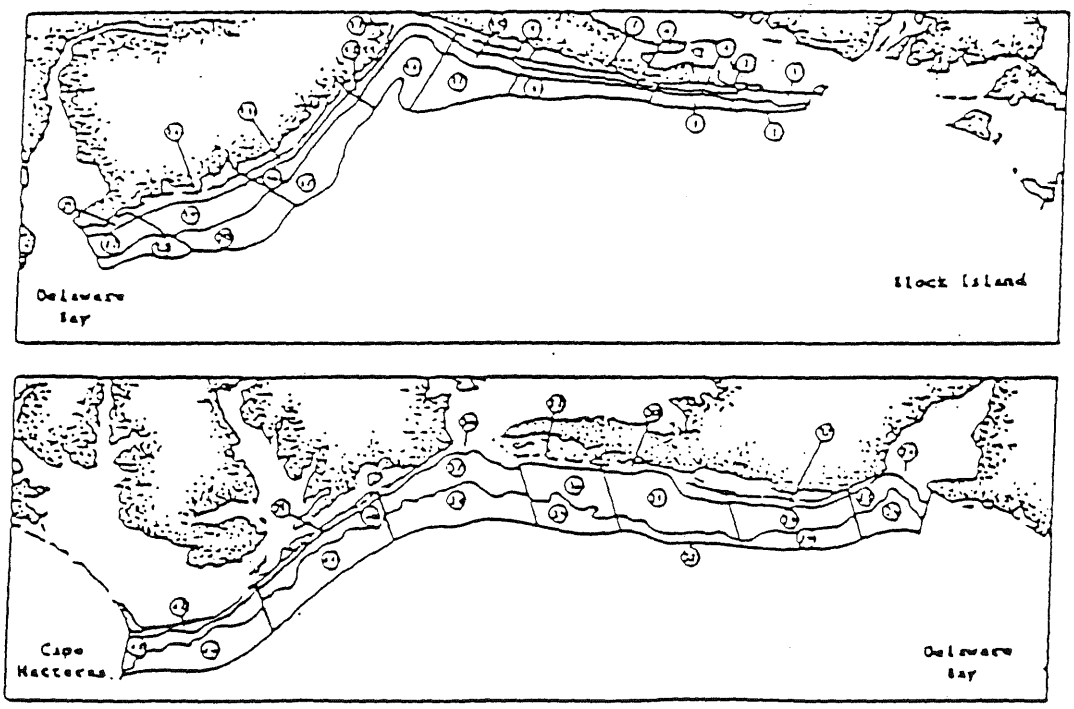


Figure 8. NMFS/NEFC inshore bottom trawl survey sampling strata.

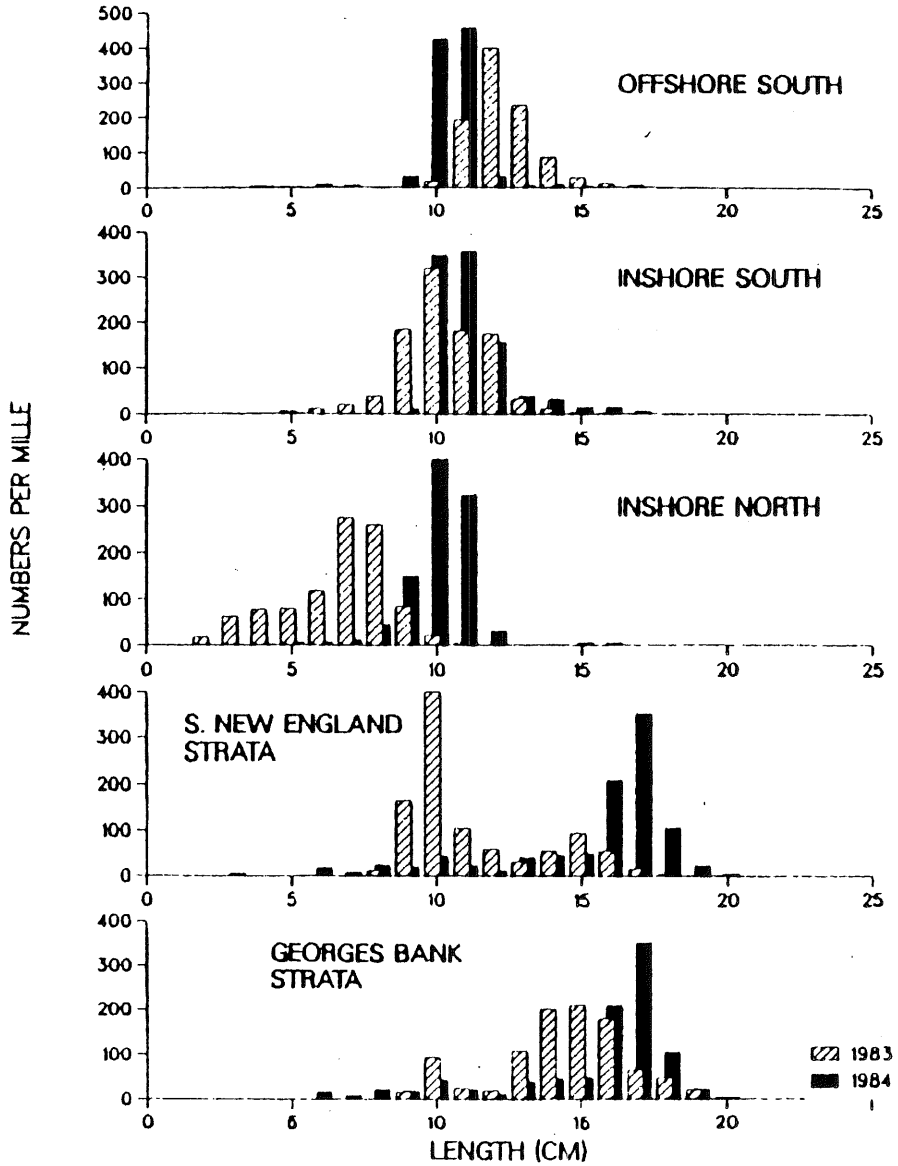


Figure 9. Length frequency distributions of butterfish taken in 1983 and 1984 NMFS/NEFC autumn bottom trawl surveys.

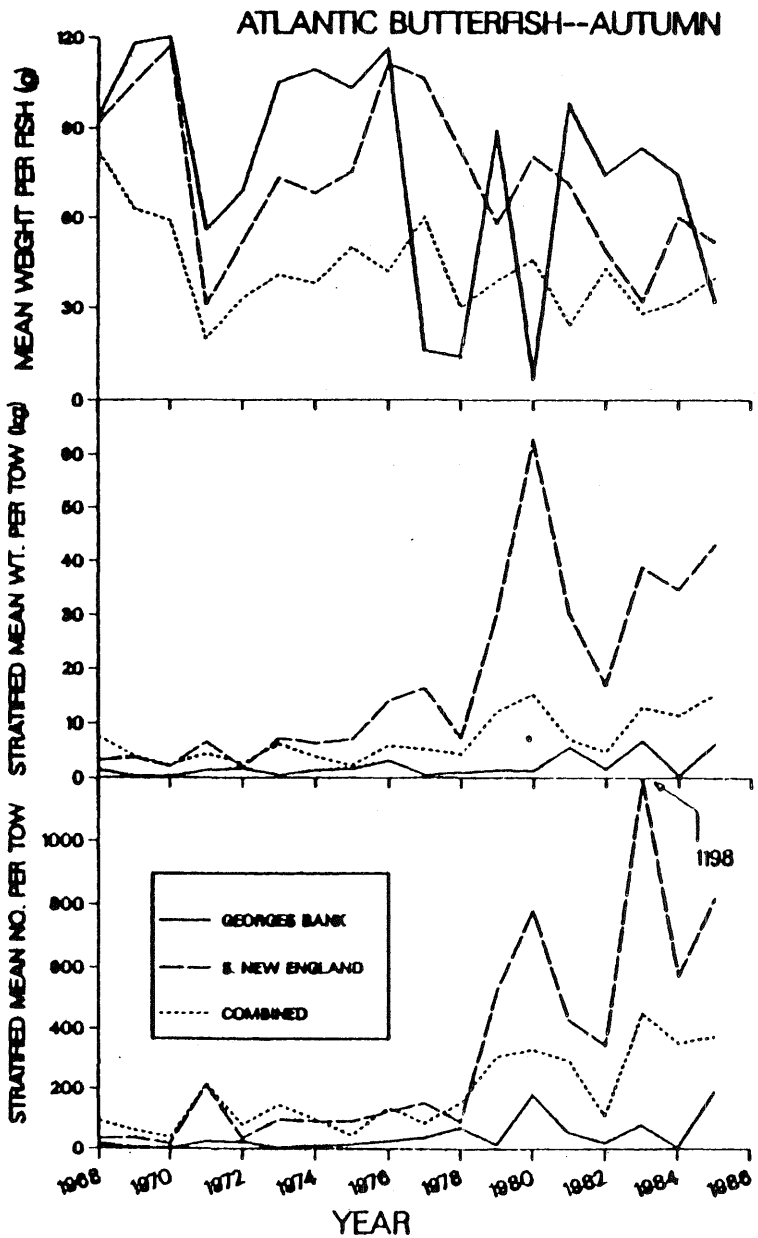


Figure 10. Butterfish abundance indices (numbers and weight) and mean weight per fish, derived from 1968-1985 NMFS/NEFC autumn bottom trawl surveys.

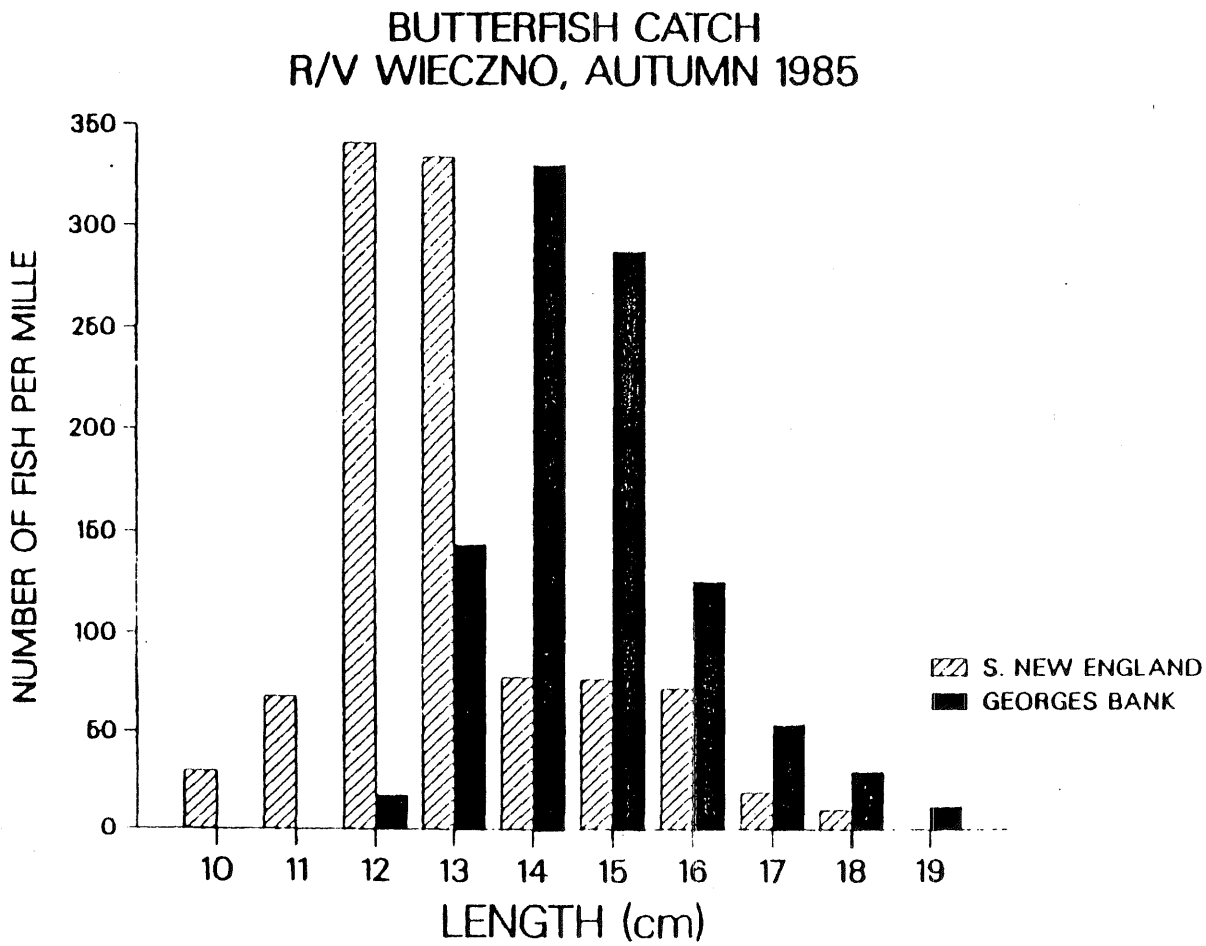


Figure 11. Length frequency distributions of butterfish taken by the Polish R/V WIECZNO in the NEFC's offshore sampling strata 6 (SNE) and on Georges Bank during a cooperative research program.

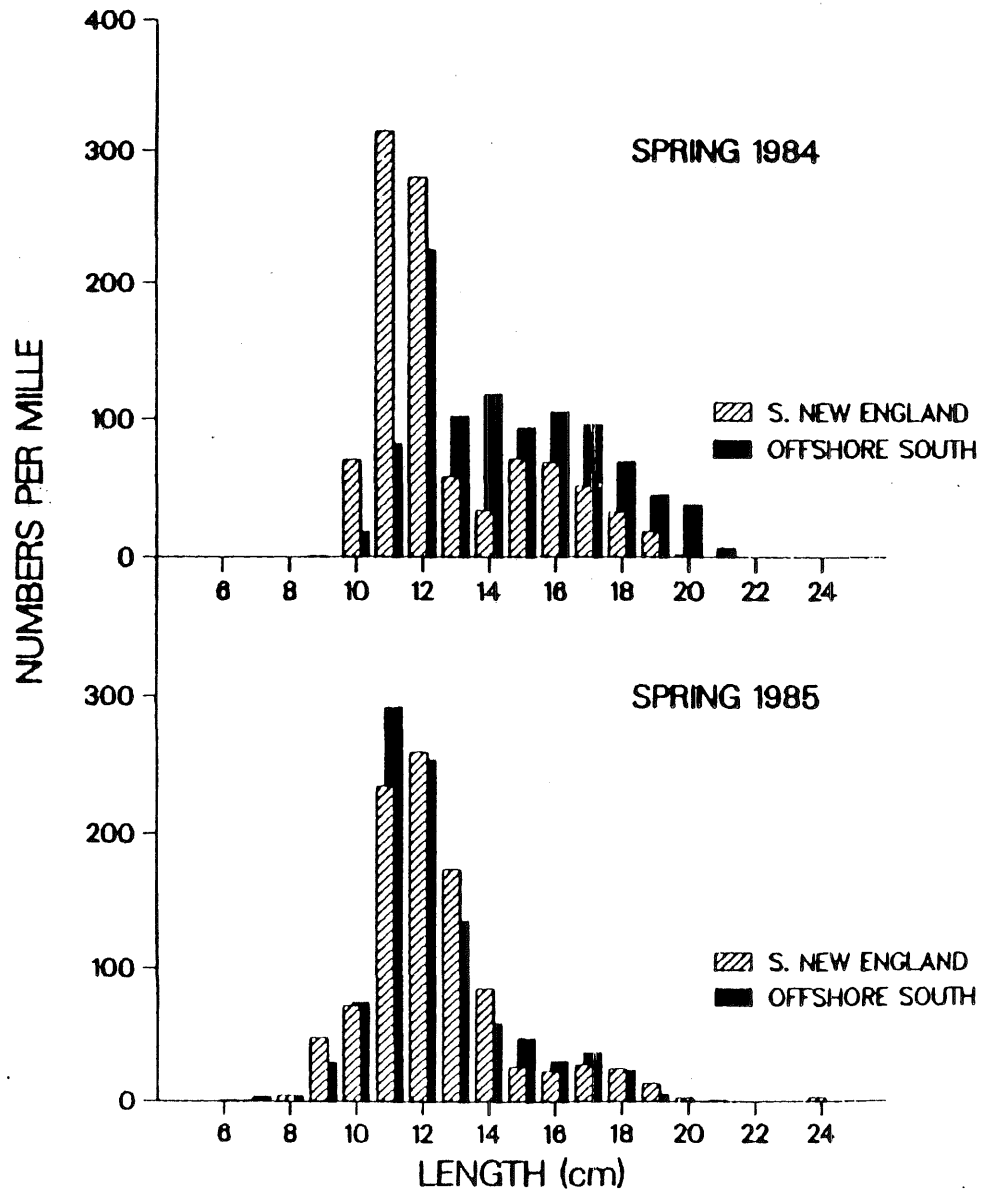


Figure 12. Length frequency distributions of butterfish taken in 1984 and 1985 NMFS/NEFC spring bottom trawl surveys.

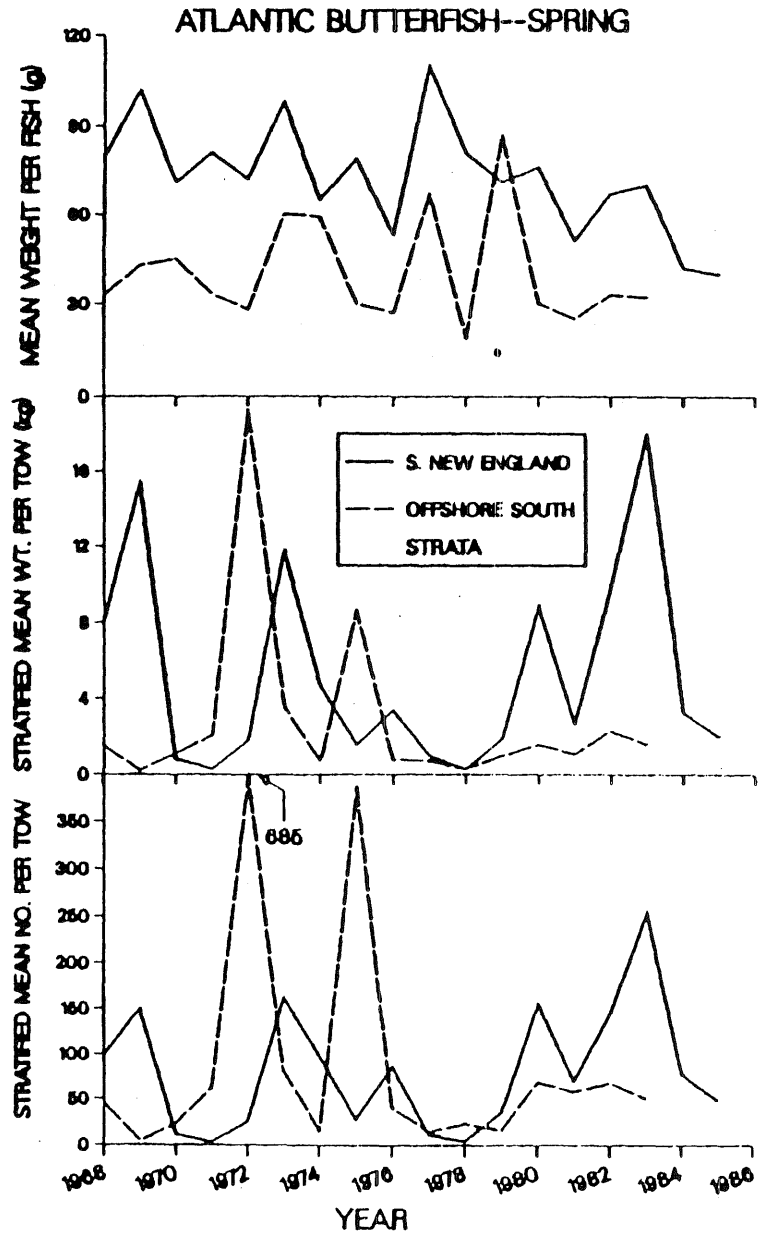


Figure 13. Butterfish abundance indices (numbers and weight) and mean weight per fish, derived from 1968-1985 NMFS/NEFC spring bottom trawl surveys.