CARICOM FISHERY REPORT NO. 1

Caribbean Community Secretariat

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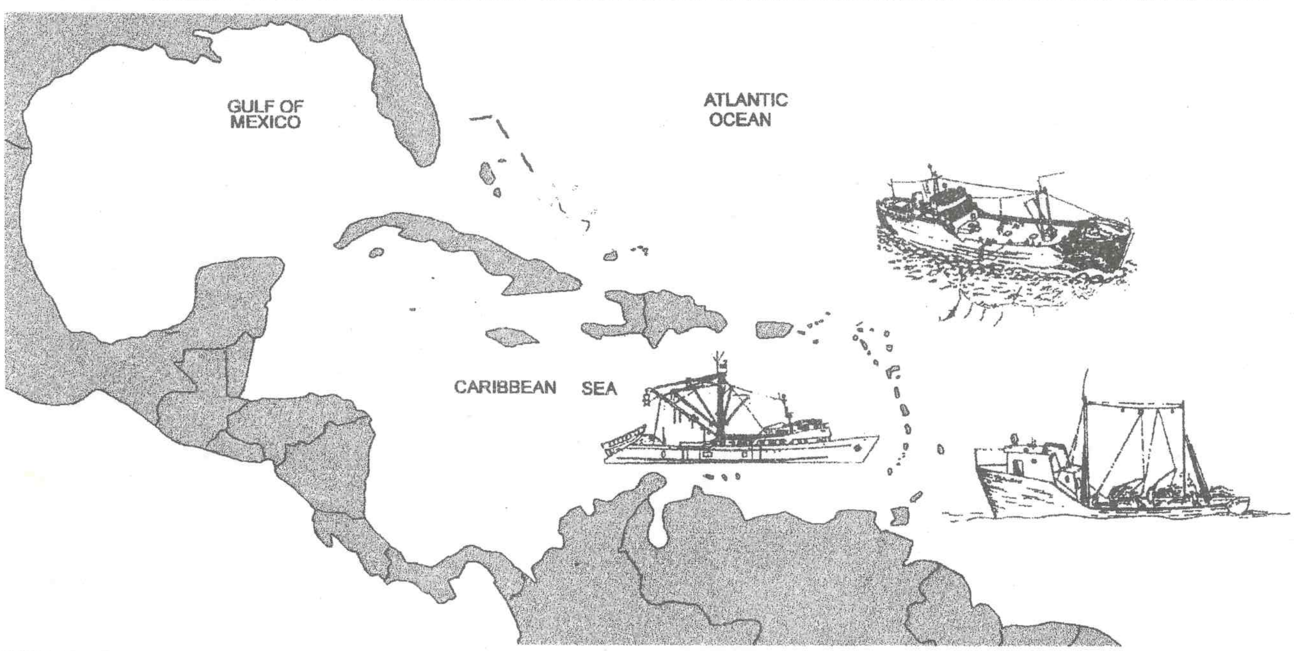
CARICOM Fisheries Unit

CATCH, EFFORT, AND CPUE TRENDS FOR OFFSHORE PELAGIC FISHERIES IN AND ADJACENT TO THE EXCLUSIVE ECONOMIC ZONES (EEZS) OF SEVERAL CARICOM STATES

MAY, 1996



CARICOM FISHERIES UNIT, BELIZE CITY, BELIZE

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Catch, effort, and CPUE trends for offshore pelagic fisheries in and adjacent to the exclusive economic zones (eezs) of several CARICOM states

by

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ABSTRACT

The International Commission for Conservation of the Atlantic Tunas (ICCAT) is responsible for the conservation of tuna, and tuna-like species found in the Atlantic Ocean. ICCAT maintains an updated database on Atlantic fishery catch and effort statistics, as well as size composition of catches. Through participation in ICCAT activities, CFRAMP has gained access to the ICCAT database, and preliminary analyses of catch and effort statistics collected by large-scale offshore fisheries operating in the Caribbean region during the period 1956-1990 are presented and discussed in this report. These analyses include examination of: species composition of the catch, the pattern of fishing effort by large-scale offshore fishing fleets operating in Caribbean and adjacent waters, and seasonal and annual trends in species abundance. This information is expected to assist CARICOM countries to estimate the amounts and species composition of catches which might be expected from offshore fishing vessels harvesting large pelagic fishes in their EEZs.

The data showed that several large offshore fishing fleets have fished for various large pelagic species in Caribbean waters. Japanese longline vessels have fished throughout the region since the 1950s, targeting mainly yellowfin tuna from 1956 to 1962 after which albacore became the principal target species. In the late 1970s, due to economic and technological developments, the Japanese fleet shifted its effort to the eastern Atlantic and temperate waters, and began targeting mainly bluefin, southern bluefin and bigeye tunas. Since the 1970s, Korean longliners have fished in most areas except in the northwest. These vessels targeted yellowfin tuna until the 1980s when bigeye tuna became the main target species.

Taiwanese longliners began operations in the 1960s with albacore as the primary target species. These vessels fished in all areas except in the northwest and off the northeast coast of South America. In 1987, bigeye and yellowfin tunas became the most important target species of the Taiwanese fleet. U.S. longline operations commenced in the region during the late 1980s, covering most areas except the extreme northeast. The main target species of this fleet was swordfish. Venezuela and Cuba also conducted longline operations since the 1970s, with the main target species being yellowfin. Venezuelan vessels tended to fish in southeast squares close to Venezuela, while Cuban vessels operated mostly east of the island chain including waters off the northeast coast of South America.

Purse seine and baitboat (pole and line) fisheries existed from the late 1960s, although effort did not become significant until the 1980s. The purse seine fisheries comprised Venezuelan and U.S. vessels fishing mostly in southern areas. In comparison, the baitboat fisheries comprised Japanese vessels in the 1970s and Venezuelan vessels from the 1980s. Baitboat vessels also operated in southern areas. Environmental conditions in the south of the region appear to make at least certain tunas, such as yellowfin and skipjack, more vulnerable to the purse seine and baitboat gears which are deployed in surface waters.

During the period studied, yellowfin and albacore generally dominated longline catches in the region. Bigeye tuna and swordfish became more prevalent during the period 1971-1990, coinciding with the period in which several fleets began targeting bigeye tuna, and the U.S.

commenced their longline activities directed at swordfish. Billfish species appeared to feature more strongly in catches taken in the northwest, possibly because of apparent lower abundance of target species in this area. In the case of purse seine and baitboat catches, these comprised mostly yellowfin and skipjack tunas, probably because these species occur closer to the surface in the areas fished.

Catch per unit of effort (CPUE) was used as an index of relative abundance. Nation trends in CPUE were often influenced by changes in target species, and in gear. However, the available data suggest that yellowfin CPUE was lower in the 1980s compared to previous years, and this agrees with trends observed in the eastern Atlantic, and with recent assessments that show a decline in Atlantic yellowfin biomass since 1970. Yellowfin appeared to be well distributed throughout the area, although somewhat lower CPUE indices were recorded in the northwest and east of the islands of Martinique and Guadeloupe. Purse seine and baitboat CPUE series were too short to determine a definite trend in time, but were similar in most areas fished except in the southeast island EEZs.

Monthly changes in yellowfin CPUE showed a peak in yellowfin abundance in southwest areas during the second and third quarters of the year, and in northern areas during the latter part of the year. On the other hand, abundance appeared to be evenly distributed throughout the year in the southeast. These patterns support the notion that the southwest Caribbean and east of the Antilles may be important spawning areas for yellowfin in the western Atlantic, and furthermore, that yellowfin move away from these areas following completion of spawning. Yellowfin may also move into southeast areas during the latter half of the year.

Albacore CPUE declined during the period studied. This trend was also observed in other parts of the northern Atlantic. Like yellowfin, albacore appeared to be less abundant in northwest areas. Certainly, primary productivity in this part of the Caribbean is notably lower than in other areas, although other environmental influences may also play an important role. Examination of the median CPUE indices suggest that albacore may migrate from southern to more northern areas during the warmer middle months of the year. It is also possible that migration out of the Caribbean Sea during these months occurs in an easterly direction into the western Atlantic Ocean.

Japanese and Korean fleets recorded an increase in bigeye CPUE in most areas fished following the introduction of deep longline gear in the late 1970s. The corresponding CPUE values of most other fleets, for which bigeye was not a major target species, were comparatively lower than those of the Japanese. In contrast, U.S. CPUE indices were similar to those of the Japanese. The CPUE trend observed in the Caribbean showed local scale changes and did not corroborate with stock abundance trends observed in other parts of the Atlantic for same period. This is because recent examination of overall Atlantic CPUE data and assessment analyses indicate a declining bigeye stock biomass.

In terms of areal differences, bigeye appeared to be relatively more abundant in south and southeast areas, and this may be related to the fact that these areas are thought to be more productive than other parts of the Caribbean and hence more favourable for concentration of tunas. The observed higher abundance of bigeye in north central and northwest areas just before and after the summer months may be due to fish migrating to and from feeding grounds believed to be located at more northern latitudes.

Billfish species were normally caught only incidentally, and hence the CPUE indices for these species were generally lower than those for the large, more commercially important tunas. In addition, the data showed no distinct trends, probably also owing to the by-catch nature of these fisheries. Certainly, examination of overall Atlantic and other directed fishery data and assessments show declines in abundance of the stocks of sailfish, blue marlin, and white marlin. Sailfish appeared to be more abundant in south and southeast areas, while the marlins were more common in northern areas. White marlin was also quite abundant along the eastern island chain. Observed monthly patterns in CPUE may have been partly driven by the seasonality of the target fisheries. Nonetheless, the data support present hypotheses that these fish undergo a north-south migration, in response to seasonal changes in water temperature. For blue and white marlin, these seasonal migrations are also believed to be related to spawning activites. In the case of white marlin, however, not many fish appear to leave southern areas in the warmer months of the year. This seems to imply that, at least for white marlin, spawning readiness may play a more important role in determining the observed migration patterns than simply changes in water temperature.

Swordfish was targeted by U.S. longliners from the late 1980s, and hence CPUE data were insufficient to determine relative changes in abundance over time. The apparent higher CPUE observed in southern areas during the first quarter of the year could be due to a higher abundance of immature fish, although there is currently no evidence to support this notion.

Skipjack tuna were usually caught in large quantities by purse seine and baitboat gear which tended to focus operations in southern areas. Purse seine catches were generally higher than baitboat catches, probably due to differences in gear efficiencies. CPUE showed no distinct trend over the period fished, and this lack of pattern has been reported for other western Atlantic data, but not for the eastern Atlantic. Areal differences in CPUE were not significant, possibly because the areas fished have similar environmental conditions. Monthly changes in CPUE were examined for a small area in the southeast. These limited data imply that skipjack abundance may be directly related to the presence of food in time and space.

INTRODUCTION

Offshore fisheries for large pelagics in CARICOM[1] countries are primarily small-scale or artisanal. Recently, most countries have declared an intention to expand their fishing capability to harvest a larger share of the pelagic species which occur in their EEZs. Rational development of these fisheries requires information on the abundance and seasonality of the various species in order to evaluate the potential returns from investment in fishing units, and to estimate appropriate licence fees for foreign vessels seeking to fish in their waters.

The International Commission for Conservation of the Atlantic Tunas (ICCAT) is responsible for the conservation of tuna, tuna-like and associated species of the Atlantic Ocean. Consequently, the onus of monitoring harvesting levels and assessing the status of these stocks currently rests with ICCAT. In view of this, ICCAT coordinates the reporting and analyses of the relevant fisheries data from those countries which harvest tuna and other related species throughout the Atlantic Ocean, and maintains a database at its headquarters in Madrid, Spain. At present, there are 22 Member Countries of ICCAT which are obliged to regularly record and submit their fisheries data for inclusion in the ICCAT database. In addition, ICCAT requests data from several non-member countries, including Taiwan which has vessels operating in the Atlantic. With regard to other non-member countries which do not regularly provide ICCAT with data, such as several CFRAMP[2] participating countries, ICCAT uses FAO fisheries statistics to complete its database.

Following the recommendations of Mahon and Murray (1992), CFRAMP has begun to participate in selected ICCAT activities and to attend relevant ICCAT inter-sessional and annual meetings as an observer. In addition, since 1993, CFRAMP participating countries have reported their annual large pelagic catch statistics directly to ICCAT through CFRAMP. One of the main benefits of ICCAT participation is that CFRAMP can readily access the ICCAT database on a regular basis. In this report, we examine the catch and effort data for those areas which include the EEZs of CFRAMP participating countries, namely, Antigua and Barbuda, Barbados. In particular, the pattern of fishing effort by large-scale offshore fleets operating in the region is presented and discussed. In addition, changes in species composition of the catch are investigated, as well as yearly and monthly trends in species abundance.

The information provided in this report is a first step towards enabling CARICOM countries to estimate the amounts and species composition of catches which might be expected from fishing vessels harvesting pelagics in their EEZs.

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[1]CARICOM (The Caribbean Community and Common Market) is responsible for ensuring economic co-operation through the Caribbean Common Market, co-ordinating foreign policy among the independent member States, and providing common services and co-operation in functional matters such as health, education and culture, communications and industrial relations. At present, there are 13 Member States of CARICOM, all from the english-speaking Caribbean.

[2]CFRAMP (CARICOM Fisheries Resource Assessment and Management Program) is a co-operative Program of the following CARICOM countries: Antigua and Barbuda, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Trinidad and Tobago.

METHODS

Description of the ICCAT Task II Catch and Effort Database

ICCAT recommends the collection of catch and effort statistics, as well as biological data. The ICCAT database is therefore organised into three categories:

- Task I data which is essentially total annual nominal catch data, normally recorded by country, species and gear;
- Task II catch and effort data, stratified by gear, time and area; and
- Task II size data, which are size frequency data, also stratified by gear, time and area.

The ICCAT Field Manual (Miyake, 1990) provides instructions for completing the reporting forms for Task I and Task II data, and samples of these forms are given in Appendix 1 of the Manual. A sample of the ICCAT reporting form for Task II catch and effort data is given in Appendix 1 of this report.

ICCAT data are supplied to CFRAMP as ASCII files with fixed-length records; in the case of Task II catch and effort data, there are 47 fields per data record, and a separate record is kept for each distinct combination of the smallest time and area strata reported (Appendix 2). Several of the fields are numerically coded for purposes of efficiency, and these codes are fully explained in Appendix 3. The fields 'File Type' and 'Record Type' each contain a single digit code used to qualify the source and accuracy of the data respectively. The field 'Country' carries a 3-digit code identifying the reporting country. The field 'Gear' has a 2-digit code used to identify the type of gear employed. Regarding the field 'Time Strata' ICCAT normally requests that Task II catch and effort data be reported by month. When it is not possible to record the month, then quarter of year, 6-month period or year is noted, using a 2-digit code.

The field 'Kind Square' contains a 2-digit code describing the fishing area: ICCAT recommends that data be reported by one degree square area (1°x1°) for surface fisheries (baitboat, also called pole and line, and purse seine) and by five degree square area (5°x5°) for longline fisheries. However, data are sometimes recorded by larger area strata, such as 5°x10° area, 10°x10° area, 20°x20° area, or by ICCAT area (ICCAT areas are described in the ICCAT Field Manual). Rectangular and square areas are identified by the coordinates of latitude and longitude at the corner of the rectangle/square closest to 0° latitude and 0° longitude. Hence, for the Northwest Atlantic, the latitude and longitude coordinates recorded would be those representing the lower right-hand corner of the rectangular or square area of fishing activities (Miyake, 1990).

The field 'Quadrant' contains a single number from 1 to 4, which denotes the quadrant of the globe in which the vessel was operating; for the Caribbean and adjacent areas in the northwest Atlantic, this number is always 4. The 'Port' field indicates the port where the data have been collected; the same codes as those for 'Country' are used, with the code 0 used when the port is unknown. The field 'Kind Catch' contains a single digit code denoting the unit of catch, e.g. 1 represents catch in metric tons. The field 'Kind Effort' contains a 2-digit code for identifying the unit of effort, e.g. 7 represents number of hooks. The 'Date' field consists of 8 characters: the first 2 digits denote the day of the month, which is followed by a hyphen, 2 digits to identify the month, then another hyphen and finally 2 digits to denote the year. The field 'Coverage Rate' usually gives the percentage of coverage rate for sampling the catch. A coverage rate of 0 means that this information has not been reported and is therefore unknown. The field '# Catches' lists the number of different species caught in the particular time-area strata combination noted for that record.

The 'Species' fields contain 2-digit codes to identify the species caught. The ICCAT database format allows for up to 15 species fields per record each within a single record which represents the catch reported for a specified time area stratum. Hence, the catches of up to 15 different species can be recorded. In addition, there are 31 possible codes (Appendix 3 lists ICCAT species codes) for identifying species and which can be extended in each of the species field. For each 'species" field, there is a corresponding 'Catch' field. There is also an 'Effort' field for each record. The 'Catch' and 'Effort' fields therefore provide actual measurement data for specified time-area strata can be up to 10 characters long, and can be accurate to one decimal place.

Data Preparation

The ICCAT ASCII data files were converted to dBASE files using the database management program Foxbase+ version 2.10 (Fox Software Inc., 1988). These dBase files were then imported into the Statistical Package For Social Sciences (SPSS/PC+), Version 4.0 (Norusis, 1990) for further preparation and analysis of the data. The majority of data were reported by five degree square (5^0 x 5^0), and hence this was the area stratum selected for data examination. Fourteen such squares, distributed over the wider Caribbean region were selected for analysis (Fig. 1). These squares include most of the EEZs of CFRAMP participating countries (Fig. 2). For the purpose of this report, each five degree square studied is identified by a four digit code: the latitude coordinates of the lower right corner of the square provide the 1st and 2nd digits of the code, while the longitude coordinates of the lower right corner of the square provide the 3rd and 4th digits of the code, e.g. square 10 60 is the five degree square containing the islands of Trinidad and Tobago, Grenada, St. vincent and the Grenadines and St. Lucia. Given the very small sea area within the square 05 60, data from this square were pooled together with data from square 05 55 for all analyses.

Using SPSS, data by ICCAT species categories were extracted and restructured to produce files with separate, specific fields containing catch data for each species category. For the region, longline effort was normally recorded as number of hooks fished, while purse seine and baitboat efforts were recorded as number of days spent fishing or less commonly, number of lines fished. Catches were usually recorded either as number of fish or weight of fish in short tons or metric tons. Catch per unit of effort (CPUE) was used as an index of relative abundance. All catch weight data, which were recorded in tons, were converted to kilograms (kg) for calculation of CPUE. Hence longline CPUE was estimated as either kg/1,000 hooks or number fish/1,000 hooks. Purse seine and baitboat CPUEs were estimated as kg/days fishing, kg/lines fished, number of fish/days fishing or number of fish/lines fished.

CPUE data were aggregated by quarter of year to produce reference tables which are available from the senior author on request. These reference tables give sufficient detail to allow the interested reader to carry out additional analyses, if desired. The original data files which include monthly catch rates are also available from the senior author on request.

Data Analysis

Maps of the Caribbean and adjacent areas were drawn to show the regional distribution of total catch and effort by gear type, using data for the most recent five year period studied, i.e. 1985-1990. The total effort by every gear type was calculated, taking into account differences in each square, fishing nation and year. These data were plotted as vertical bar charts to show changes in effort with nation and area, as well as time and gear trends.

To obtain sufficient data for analysis of species composition of the catch, records were grouped into two time periods: the first period covered the years 1956 to 1970, and the second period included data for the years 1971 to 1990. Within these two time periods, the total catch of each species category and hence the percentage composition of the catch was calculated, taking into account differences in each square, catch type (number of fish or weight of fish) and each gear type. These data were plotted as horizontal stacked bar charts to show the changes in species composition with changes in square, time period, gear type, and catch type (in number or weight).

To examine changes in species abundance during the period 1956-1990, the mean CPUE for each year was calculated for each species category, taking into account differences in each square, catch type, gear type and hence effort type (number of hooks or days fishing), and fishing nation. Mean CPUE was plotted against year for each possible square-catch type-gear type-effort type combination.

Seasonal changes in species abundance were examined by constructing box and whisker plots of standardised monthly mean CPUE for each month of the calendar year. To do this, monthly mean CPUE indices were calculated, taking into account differences due to square, gear type, effort type, catch type and hence CPUE units. Monthly mean CPUE indices were then standardised to the corresponding yearly mean CPUE, i.e. each monthly mean CPUE index was divided by the mean CPUE for the relevant year. This standardisation reduced the inter-annual differences for each month's data so that monthly differences could be more easily discerned. In this analysis, the box and whisker plots show the full range of observed standardised monthly mean CPUE indices: the box indicates the range of the core 50% values with the horizontal line within the box representing the median value, and the whiskers show the limits of the distribution, that is, the minimum and maximum values.

RESULTS

Fourteen five degree squares in the wider Caribbean region were selected for data analysis (Fig. 1). These squares include most of the EEZs of CFRAMP participating countries, shown in Fig. 2.

Fishing effort

The main gears used by the large-scale offshore fleets fished for oceanic pelagics are longline, purse seine, and pole and line (referred to as baitboat). Trolling, the main method for artisanal fishers in CARICOM countries, is seldom used, and when recorded is usually categorised as "other and unclassified gear". The overall distribution of fishing effort by longlines, purse seines and baitboats in the area under consideration is shown in Fig. 3a,c,&e. The corresponding catch is shown in Fig. 3b,d&f.

Longline effort is clearly highest in the Atlantic east of the Lesser Antilles and in square 20 75 that lies in the Gulf of Mexico, and lowest in the western Caribbean Sea (squares west of 70^0 W and south of 20^0N) (Fig. 3a). Catch, however, is relatively evenly distributed among the squares, and does not appear proportional to effort, except in the two squares east of the northern Lesser Antilles (squares 15 50 and 15 55) (Fig. 3b). Purse seine effort is highly localised in the square 10 65 off western Venezuela (Fig. 3c). Although catch is relatively high in this square, it is higher still two squares to the west, in square 10 75 (Fig. 3d). Baitboat effort is also highly localised (Fig. 3e) in the same square as purse seine effort (Fig. 3c), but catch is more widely distributed along the north coast of South America and along the eastern island chain (squares 05 55, 10 50 to 10 75, and 15 60) (Fig. 3f).

The trends in fishing effort by gear and nation are shown for all squares combined (Fig. 4) and separately for each square (Figs 5, 6, and 7). The segments of the bars in the bar charts are stacked in the same sequence as shown in the keys. Therefore, when segments are too small to show the fill, they can be interpreted according to the sequence in the key.

Longline

The sequence of participation of the various countries in longline fishing in the region is most clear in the figure for all squares combined (Table 1 a-n and Fig. 4a). Japanese longliners were the first to exhibit a significant presence in the region in the late 1950s and increased their effort through the late 1960s. By the end of the 1960s, Japanese effort decreased due to the departure of the fleets for the eastern Atlantic and temperate waters. In 1967, Taiwanese vessels began to fish and have continued to exert a significant proportion of the longline effort in the region through to the present, with two modes, one in 1973-74 and the other in 1985-86. Venezuelan effort was first recorded in 1970, but remained at a relatively low level of effort until 1983 when there was increased activity by Venezuelan longliners until 1987. Korea appeared shortly after Venezuela, and exerted a notable level of effort from 1974 through to 1979. Korean effort was greatest in the latter half of the 1970s, though vessels continued to operate until 1986. Cuban effort was substantial only for a few years from 1984 through 1987, and the effort by the USA is a reflection of the expansion of activity of their swordfish fleet into the Caribbean during the 1980s.

There are spatial differences in the distribution of effort among the fourteen squares (Table 1 a-n and Figs. 3a and 5). Japanese fishing effort, though distributed throughout the squares under consideration, was most intensive east of the Lesser Antilles in squares 10 55 and 10 50, and in the central and southwest squares 15 75 and 10 75 respectively. Taiwanese longliners have also operated throughout the region but most intensively in the area of, and particularly east of the northern Lesser Antilles. During the 1970s they tended to fish more in square 15 65 than they did in the 1980s, possibly due to increased US surveillance in their Caribbean fishing zone off Puerto Rico and the USVI following its establishment in the early 1980s.

Venezuelan longline effort was reported as being mainly in the southeast, in square 10 60, and to a lesser extent off the northeast coast of South America in squares 05 50, 05 55. These are also the areas in which Cuban longline fishing effort was predominant, as well as in squares 10 50 and 10 55.

The majority of effort by Korea was reported for the squares to the east of the Lesser Antilles (10 55, 10 50, and 10 60). For the USA, most effort was in the squares over the Lesser Antilles (10 60, 15 60 and 15 65).

Purse seine

Purse seine fishing in the area under consideration has been dominated by two countries, USA and Venezuela (Table 1 a-n and Fig. 4b). Most of the effort by the USA was exerted between 1975 and 1981, although they have fished in the area in other years. Venezuelan purse seiners began operations in 1983 and exerted maximum effort in 1984 after which effort decreased and remained more or less stable for the rest of the period. This is due to a shift in their area of operation from the Caribbean to the eastern Pacific.

Purse seine activity has been primarily southern and southeastern squares, with Venezuelan effort being concentrated in squares 05 55, 10 55, 10 60 and 10 70 (Table 1 a-n and Figs. 3c and 6). Effort by the USA was more widely distributed, although their highest effort was in squares 05 50, 05 55, and 10 60. There has not been any appreciable purse seine effort in the row of squares above latitude 15^0 N extending from east of the Lesser Antilles through the area of Jamaica to the waters off Belize (15 55 to 15 85).

Baitboat

Apart from a small amount of activity by Japan during the period 1973-1975, only Venezuela has been engaged in baitboat fishing (Table 1 a-n and Fig. 4c). Venezuelan baitboat operations commenced in 1982. Effort peaked in 1984 and has shown a declining trend since. The majority of this effort has been in squares 05 55, 10 55 and 10 60 (Table 1 a-n and Figs. 3e and 7), with virtually none in western and northern Caribbean squares.

Species Composition

The species which comprise the majority of the catch of large oceanic pelagics are: bluefin tuna (*Thunnus thynnus thynnus*), yellowfin tuna (*Thunnus albacares*), albacore (*Thunnus alalunga*), bigeye tuna (*Thunnus obesus*), blue marlin (*Makaira nigricans*), white marlin (*Tetrapturus albidus*), Atlantic sailfish (*Istiophorus albicans*), and swordfish (*Xiphias gladius*). In some cases, billfishes are not identified by species. Several other species, most of them small in size are caught in small quantities. These include: Atlantic bonito (*Sarda sarda*), blackfin tuna (*Thunnus atlanticus*), Atlantic black skipjack (*Euthynnus alletteratus*), wahoo (*Acanthocybium solandri*), several mackerel species (*Scomberomorus* spp.), and *Auxis* spp.. Due to the low commercial value of these species to the large-scale offshore fleets, they are often not recorded separately. (Appendix 3, Table A3.4).

The composition of the catch differed considerably among the major gear types (Table 2 a-n). Figs. 8, 9 and 10 show the percentage composition of the catch by gear, square, time period and recorded catch unit. The segments of the bars in the bar charts appear in the same sequence from left to right as shown in the keys. Therefore, when segments are too small to show the fill, they can be interpreted according to the sequence in the key. (See Appendix 3 (Table A3-4) for explanation of the species codes used in the tables and figures 8-10).

Longline

Species composition of the longline catch is known to vary with the depth at which the gear is set. However, when the data are aggregated by area, catches from all longline gear are combined.

Yellowfin tuna was clearly dominant in the longline catch over most of the area under consideration (Table 2 a-n and Fig 8). Albacore was a prominent component throughout the area and was dominant in catches taken in the northeast squares, 15 55 and 15 65. This species was least abundant in the squares off the north and northeast coasts of South America, 05 50, 05 55, 10 60, 10 70 and 10 75.

Bigeye tuna formed a consistent component of the catch, whose contribution was generally higher during the second time period (1971-1990). Towards the western Caribbean, the dominance of yellowfin and albacore gave way to billfishes in squares 15 75 to 15 85. Billfishes were least important in catches taken in the northeast square 15 55. Swordfish was only a significant component of the catch in the second time period, 1971-1990. This is a reflection of the expansion of activity by the US swordfish fleet into the Caribbean during this time. The contribution of swordfish was particularly high in the area of the southeastern Caribbean, 10 60, but was also considerable in northeast and northcentral squares 15 60 to 15 75.

Purse Seine

Except for square 15 60, species composition in purse seine catches was similar in all the squares in which these vessels operated, generally consisting of about 45-60% yellowfin tuna, 35-55% skipjack tuna, and 5-10% other species by weight (Table 2 a-n and Fig. 9). In square 15 60, the catch consisted only of bigeye tuna which are not normally caught in large quantities by purse seine gear.

Baitboat

The majority of baitboat catches comprised mostly yellowfin and skipjack tunas (Table 2 a-n). However, the relative proportions of these species were more variable from square to square than was the case for purse seine catches (Table 2 a-n and Fig. 10). This was probably due to the relatively small size of catches taken by this gear.

Changes In Species Abundance During The Period 1956-1990

Figs. 11-28 show changes in annual mean CPUE during the period 1956-1990 for several tuna and billfish species, by square and fishing nation.

Longline

Longline vessels from Japan, Taiwan, U.S.A., Venezuela, Cuba, and Korea have conducted fishing operations in the Caribbean during the period 1956-1990. All these nations except Korea reported their catches in terms of number of fish, and hence CPUE was estimated as number of fish/1,000 hooks. Korea and some Venezuelan vessels reported their catches in terms of weight in metric tons or short tons, and hence their CPUE was estimated as kg/1,000 hooks.

Yellowfin tuna

During 1956-1990, the annual mean CPUE for yellowfin tuna showed a general decline, especially so in the case of Japanese and Taiwanese data, although the observed decline was not as marked in southwest Caribbean squares as in the rest of the region (Fig. 11a, b). Other nations caught yellowfin tuna in the region in the latter part of the period but their CPUE indices were not as high as the CPUE indices reported by the Japanese fleet during the 1950s and early 1960s. The Korean fleet, like the Japanese and Taiwanese, operated throughout the region: however, the Korean yellowfin CPUE generally tended to fluctuate in all squares fished, showing notable inter-annual variability (Fig. 12). Except for western squares and square 15 55, Korean CPUE tended to be lower in the 1980s.

In terms of no. fish/1,000 hooks, comparatively lower CPUE indices were more commonly obtained in the northwest Caribbean squares 15 75, 15 80 and 15 85, and northeast of the island chain, in square 15 55 (Fig 11a). In terms of kg/1,000 hooks, no data were available for squares 15 80 and 15 85; CPUE indices were generally similar in other squares fished except for square 15 55 in which CPUE indices were comparatively lower except for the CPUE recorded in 1983 (Fig 12).

Albacore

The Japanese data showed a continuous and sometimes dramatic decline in annual mean albacore CPUE from >20 fish/1,000 hooks during the 1950s and early 1960s to <5 fish/1,000 hooks in the late 1970s (Fig. 13a, b). Taiwanese vessels began fishing in the area in the late 1960s, and generally recorded higher CPUE indices than the Japanese in similar squares and time periods. Taiwanese albacore CPUE declined more gradually than Japanese CPUE in the southern squares 10 60, 10 70, and 10 75, and in the northeast square 15 55. From 1970 onwards, Venezuelan, U.S. and Cuban vessels also fished albacore mostly in southern and northeast and northcentral squares: these nations usually recorded CPUE indices of less than 10 fish/1,000 hooks (Fig. 13). Korean vessels recorded albacore catches from 1974, and like the Japanese and Taiwanese, Korean effort was fairly widespread (Fig. 14). Korean albacore CPUE tended to fluctuate periodically, ranging from 0 to almost 700 kg/1,000 hooks, with declines in CPUE over time apparent only in squares 05 50, 05 55, and 15 65.

In terms of no. fish/1,000 hooks, CPUE indices were comparatively lower in western Caribbean squares (10 70, 10 75, 15 85, and 15 80) than in other areas. In terms of kg/1,000 hooks, CPUE indices were generally lower than those for yellowfin. The highest CPUE indices were observed in eastern Caribbean squares (15 60, 15 55, 10 55, 10 50, and 05 55) (Fig. 14).

Bigeye tuna

The annual mean CPUE was generally less than that estimated for yellowfin tuna. Japanese CPUE increased from about 2 fish/1,000 hooks in the 1950s to more than 8 fish/1,000 hooks in most squares in the 1980s (Fig. 15a, b). Venezuelan, Taiwanese and Cuban CPUE indices were lower than Japanese CPUE indices in most years. However, when U.S. vessels began recording bigeye catches in the region in the late 1980s, the U.S. CPUE indices were comparable to those of the Japanese in the squares fished (Fig. 15). Korean vessels recorded bigeye catches in the region from 1974 (Fig. 16). In the squares fished, Korean CPUE tended to fluctuate periodically, with no definite trend except for a gradual increase observed in squares 15 65, 10 50, 05 50, and perhaps 10 55. Inter-annual differences in the Korean CPUE ranged from less than 10 kg/1,000 hooks to as much as almost 1000 kg/1,000 hooks.

In terms of no. fish/1,000 hooks, the highest CPUE indices were recorded in southern and southeast squares (10 75, 10 60, 10 55, 10 50, 05 55, and 05 50) (Fig. 15b). In terms of kg/1,000 hooks, the highest CPUE indices were recorded in the southeast squares 10 55, 10 50, 05 55, and 05 50 (Fig. 16).

Sailfish

Japanese vessels which fished in the area throughout the time period recorded their highest sailfish CPUE indices during the 1960s and early 1970s. Nonetheless, estimated annual mean CPUE indices for sailfish were generally lower than those obtained for yellowfin, albacore and bigeye. Besides the decline noted in Japanese data in the late 1970s and 1980s, CPUE showed no clear, consistent trend for any nation in any of the squares fished (Figs. 17a, b, & 18). Inter-annual fluctuations in CPUE were usually small, but inter-annual differences of 14 fish/1,000 hooks and >50 kg/1,000 hooks have been recorded.

In terms of no. fish/1,000 hooks, the highest CPUE indices were recorded in southeast squares 05 50, 05 55, 10 60, and the northwest square 15 85 (Fig. 17). High CPUE indices were also recorded in squares 10 75 and 15 80. In terms of kg/1,000 hooks, highest CPUE indices were recorded in the southeast squares, 05 55 and 10 55 (Fig. 18). The lowest CPUE was recorded in the northeast, in square 15 55.

Blue marlin

Japanese CPUE showed marked fluctuation with CPUE generally lower in the late 1970s and 1980s in several squares. In comparison, Taiwanese CPUE gradually declined during the period in most squares except in the southeast. Besides these observed patterns, estimated annual mean CPUE indices showed no distinct trends for any nation in the squares fished (Figs. 19a, b, & 20). Inter-annual fluctuations in CPUE were small, with the highest inter-annual differences of 10-11 fish/1,000 hooks and about 85 kg/1,000 hooks recorded by Japanese and Korean vessels respectively.

In terms of no. fish/1,000 hooks, the highest CPUE indices were recorded in the northern squares 15 85, 15 80, 15 75, 15 70 and 15 65 (Fig. 19b). In terms of kg/1,000 hooks, the highest CPUEs were recorded in squares 10 75 and 15 55, although generally CPUE indices did not appear to differ significantly among the squares fished (Fig. 20).

White marlin

Generally, estimated annual mean CPUE indices for white marlin were similar to those observed for blue marlin (Figs. 21a, b, & 22). Besides the Japanese vessels which recorded higher CPUE indices during some years in the 1960s, no distinct trends were observed by any other fleets in any of the squares fished. Notable inter-annual variability in mean CPUE were sometimes observed, as high as 21 fish/1,000 hooks in square 15 80, and 37 kg/1,000 hooks in square 10 60, recorded by Japanese and Korean vessels respectively.

In terms of no. fish/1,000 hooks, the highest CPUE indices were recorded along the eastern island chain in squares 10 60 and 15 60, and in the north of the region in squares 15 75, 15 80, and 15 85 (Fig. 21). In terms of kg/1,000 hooks, the highest CPUE indices were also recorded in squares 10 60, and 15 60, as well as in the southeast square 10 50 (Fig. 22).

Swordfish

Given that Japanese and Taiwanese CPUE indices were very low, and there were only 4 years of U.S. CPUE information, these data are not illustrated graphically here. It should be noted that U.S. swordfish CPUE indices ranged from 2 fish/1,000 hooks to >70 fish/1,000 hooks, but were often >20 fish/1,000 hooks during 1987-1990 when U.S. longline vessels specifically targeted swordfish. Korean CPUE indices tended to fluctuate from year to year with no obvious trend (Fig. 23). Inter-annual differences in mean CPUE of >40 kg/1,000 hooks were sometimes recorded.

Generally, U.S. CPUE indices (no. fish/1,000 hooks) were similar in all squares fished, being only slightly lower in squares 05 50, 05 55, and 10 50. Similarly, Korean CPUE indices (kg/1,000 hooks) did not differ much among squares fished, although slightly lower CPUE indices were observed in squares 05 55, 10 70, and 15 55.

Billfishes (combined)

No distinct trends were observed in any of the squares fished (Fig. 24). In addition, notable inter-annual fluctuations in CPUE were often observed. CPUE indices did not appear to differ much among squares fished, although indices obtained for the eastern part of the island chain and in coastal areas of the South American continent tended to be higher than for other areas.

Purse seine

The U.S. conducted purse seine fishing operations in the south of the region (including and between squares 10 70 and 05 50) during 1968-1986. Venezuelan purse seine vessels commenced fishing operations also in the south of the region in 1983.

Yellowfin tuna

CPUE indices tended to fluctuate markedly from year to year with no distinct trend in any of the squares fished (Fig. 25). The highest CPUE indices were obtained by Venezuelan vessels in squares 10 60 and 10 70.

Skipjack tuna

The majority of catches were taken by Venezuelan vessels. Estimated annual mean CPUE indices sometimes showed marked inter-annual fluctuation with no distinct overall trend (Fig. 26). The highest CPUE indices, exceeding 30,000 kg/day fished, were observed in square 05 55 and 10 70.

Baitboat

Venezuela conducted baitboat fishing operations in southern areas (including and between squares 10 70 and 05 55) from 1982 onwards.

Yellowfin tuna

Generally, the estimated annual mean CPUE indices were of similar magnitude to those obtained by purse seine vessels. CPUE indices appeared to be higher in the late 1980s, although the CPUE series probably do not cover a sufficient number of years to confirm this trend (Fig. 27). In addition, CPUE indices did not appear to differ significantly among the squares fished, although somewhat lower indices were observed in square 10 60.

Skipjack tuna

Estimated annual mean CPUE indices for skipjack tended to be lower than the corresponding purse seine CPUE indices. CPUE indices fluctuated with no distinct overall trend observed in any of the squares fished (Fig. 28). Estimated indices did not appear to differ significantly among squares, but were generally lower in square 10 70.

Seasonal Changes In Species Abundance

Longline

Yellowfin tuna

For CPUE indices estimated as no. fish/1,000 hooks, insufficient data were available to examine seasonal changes in abundance in squares 15 85 and 15 55. For squares 15 80, 15 75, and 05 55, data for the entire period, 1956-1990, were used to construct the monthly box and whisker plots. For remaining squares, plots were constructed using data from 1971-1990 only. For CPUE indices estimated as kg/1,000 hooks, sufficient data were available only for the four squares, 10 60, 10 55, 10 50, 05 55, and 05 50. The box and whisker plots for these squares were constructed using data for the period 1971-1990 only.

Examination of standardised monthly mean CPUE indices, where CPUE was estimated as no. fish/1,000 hooks, indicated possible seasonal changes in yellowfin abundance in all areas of the Caribbean except in the southeast. In northern squares except 15 75, median standardised CPUE indices were higher during the last 4-5 months of the year (Fig. 29). In square 15 80, median standardised CPUE indices were higher during the period November-February. On the other hand, in the southwest squares 10 75 and 10 70, median indices were slightly higher during May-October and April-August respectively than in the remaining months of the year. In contrast, no distinct monthly patterns were observed in the southeast squares 10 60, 10 55, 10 50, 05 55, 05 50.

Changes in standardised monthly mean CPUE indices, where CPUE was estimated as kg/1,000 hooks, are illustrated in Fig. 30. In squares 10 60 and 05 55, standardised CPUE indices during the second half of the year appeared to be slightly higher than those obtained during the first half of the year. No discernable pattern was observed in other southeastern squares (10 55, 10 50, and 05 50).

Albacore

For CPUE indices estimated as no. fish/1,000 hooks, insufficient data were available to examine seasonal changes in abundance in squares 15 85, 15 80 and 15 55. For squares 15 75, and 05 55, data for the entire period, 1956-1990, were used to construct the monthly box and whisker plots. For remaining squares, plots were constructed using data from 1971-1990 only. For CPUE indices estimated as kg/1,000 hooks, sufficient data were available only for the four squares, 10 60, 10 55, 10 50, and 05 50. These plots were constructed using data for the period 1971-1990 only.

Changes in standardised monthly mean CPUE indices, where CPUE was estimated as no. fish/1,000 hooks, are illustrated in Fig. 31. In the northeast squares, 15 65 and 15 60, standardised CPUE indices appeared to be higher during the first 5-6 months of the year than in other months, with the highest median index observed in May and in June respectively. In comparison, in the southern squares 10 75, 10 70, and 10 60, median standardised CPUE indices were notably lower during June, and July than in remaining months of the year. In squares 10 50 and 05 50, median standardised CPUE indices appeared to be higher during June-September and April-July respectively. In other squares fished, 15 75, 15 70, 10 55 and 05 55, there appeared to be no distinct seasonal pattern, although slightly higher median indices were observed during April and during August-October in squares 15 75 and 15 70 respectively (Fig. 31).

Changes in standardised monthly mean CPUE indices, for CPUE data estimated as kg/1,000 hooks, are shown in Fig. 32. In squares 10 60 and 10 55, monthly changes in standardised CPUE indices showed no clear pattern. However, in square 10 50, median indices were slightly higher during March-July than in other months. Similarly, in square 05 50, a comparatively higher median standardised CPUE was observed in February.

Bigeye Tuna

For CPUE indices estimated as no. fish/1,000 hooks, insufficient data were available to examine seasonal changes in abundance in squares 15 85 and 15 55. For squares 15 80, 15 75, and 05 55, data for the entire period, 1956-1990, were used to construct the monthly box and whisker plots. For remaining squares, plots were constructed using data from 1971-1990 only. For CPUE indices estimated as kg/1,000 hooks, sufficient data were available only for the four squares, 10 60 10 55, 10 50, and 05 50. The box and whisker plots were constructed using data for the period 1971-1990 only.

Fig. 33 shows changes in standardised monthly mean CPUE indices, where CPUE was estimated as no. fish/1,000 hooks. Different monthly patterns were observed in the north, south and southeast, as well as slight differences between adjacent squares along the same latitude. For instance, in square 15 80, median standardised CPUE indices appeared to be highest during the months January-February and during September-October, and lowest during May-August and in December (Fig. 33). On the other hand, in the adjacent square 15 75, the highest median indices were observed during March-April with another smaller peak occurring during October-November; median indices were lowest during July and August. Similarly, in the next square 15 70 which lies on the same latitude, highest median standardised CPUE indices were observed during May-June and during November-December, while median indices tended to be lowest during April and July. In contrast, in the northeast squares 15 65 and 15 60, there appeared to be no distinct monthly patterns.

In the southwest square 10 75, median standardised CPUE indices were highest during June-October and lowest in April. In comparison, in the adjacent square 10 70, median indices peaked slightly in January and in July, being comparatively lower in March and during November-December. In the southeast square 10 60, there was no marked monthly pattern although a comparatively higher median standardised CPUE was observed in July with the lowest median index occurring in September. In the adjacent squares 10 55, 10 50, 05 55, and 05 50, median standardised CPUE indices generally showed no distinct monthly pattern; however, the highest median indices were observed in September in 10 55, during October-November in 10 50, during July and October-November in 05 55, and during November in 05 50 (Fig. 33).

Changes in standardised monthly mean CPUE indices, where CPUE was estimated as kg/1,000 hooks, are illustrated in Fig. 34. Except for square 10 55, these data showed no distinct monthly patterns. In square 10 55, median standardised CPUE indices reached a notable maximum in October. In the other squares, comparatively high median indices were observed during October in 10 60, in December in 10 50, and in May and October in 05 50.

Sailfish

Sufficient data (CPUE recorded as no. fish/1,000 hooks only) were available only for six squares, the north central square 15 65 and the two southern squares 10 75 and 10 70, and three southeast squares 10 60, 10 55, and 05 50. For squares 15 65, 10 70, 10 60, and 10 55, data for the entire period, 1956-1990, were used to construct the monthly box and whisker plots. For remaining squares, plots were constructed using data from 1971-1990 only.

In square 15 65, standardised CPUE indices did not appear to vary significantly throughout the year (Fig. 35). In contrast, in square 10 75, median standardised CPUE indices were notably higher during the months June-July. A similar but less distinct trend was observed in square 10 70. On the other hand, in square 10 60, individual indices fluctuated more or less evenly throughout the year, although the median standardised CPUE for February was markedly higher than corresponding indices in other months. No distinct monthly pattern was apparent in square 10 55, with highest median indices observed in May and June. In square 05 50, the highest median standardised CPUE was observed in August, while very high individual standardised CPUE indices were obtained in April and December.

Blue marlin

Insufficient data were available to examine seasonal changes in abundance in squares 15 85, 15 80, 15 55, and 05 55. For squares 15 75, 15 70, and 10 60, data for the entire period, 1956-1990, were used to construct the monthly box and whisker plots. For remaining squares, plots were constructed using data from 1971-1990 only. For all squares, CPUE was estimated as no. fish/1,000 hooks.

In square 15 75 which includes Jamaica's EEZ, the highest median standardised CPUE was observed in December (Fig 36). High standardised CPUE indices were also obtained in April and in June. In the adjacent square 15 70, high indices were observed during March-April, with April also having the highest median standardised CPUE. On the other hand, in square 15 65, individual indices tended to be slightly higher during the period June-August, with the highest median index observed in August. To the east of 15 65, in square 15 60 which includes several Leeward Island EEZs, median indices reached a peak in June and then again during September-October (Fig. 36).

In the southwest square 10 75, median indices remained fairly constant throughout the year, increasing slightly in November and reaching a maximum during December-January. A December peak in median standardised CPUE was also observed in the nearby square 10 70, although a smaller peak was also evident during the period April-June (Fig. 36). In the southeast square 10 60, median indices showed two quite distinct peaks: during January-March and during October-December. In other southeast squares which lie to the east of the island chain, 10 55, 10 50, and 05 50, no distinct monthly patterns were apparent. However, in these squares, very high individual standardised CPUE indices were observed during February, and also during March-May in 10 50 and during March-April in 05 50. These indices tended to be slightly high also during September-November in both 10 50 and 05 50.

White Marlin

For squares 15 70, 10 60, and 10 55, data for the entire period, 1956-1990, were used to construct the monthly box and whisker plots. For squares 15 65, 10 75, 10 70, and 05 50, plots were constructed using data from 1971-1990 only. Insufficient data were available to examine seasonal changes in abundance in other squares. For all squares, CPUE was estimated as no. fish/1,000 hooks.

In north central square 15 70, standardised CPUE indices showed no distinct monthly pattern, except that indices remained lowest during December-February (Fig. 37). The highest median index was observed in March. In the adjacent square 15 65, median standardised CPUE indices were highest during the period January-June, reaching a maximum value in May. In the southwest square 10 75, median indices were comparatively slightly higher during the period May-September. In comparison, in the adjacent square 10 70, median standardised CPUE indices fluctuated throughout the year, showing no significant trend; the highest median index was observed in November.

In the southeast square 10 60, median standardised CPUE indices were notably higher during January and February (Fig. 37). However, very high individual indices were observed during April, November and December. To the southeast of the island chain, in square 10 55, two slight peaks in median standardised CPUE were apparent: during February and in November. In both 10 60 and 10 55 indices were lowest during May-August. In comparison, in the nearby square 05 50, very high individual standardised CPUE indices were observed in February, March, April, and December. However, median standardised CPUE was highest in August.

Swordfish

For squares 15 80, 15 75, 15 70, and 05 55, data for the entire period, 1956-1990, were used to construct the monthly box and whisker plots. For all squares except 15 85, and 15 55, plots were constructed using data from 1971-1990 only. Insufficient data were available to examine seasonal changes in abundance in squares 15 85 and 15 55. For all squares, CPUE was estimated as no. fish/1,000 hooks.

In the northwest square 15 80, standardised CPUE indices increased and decreased in pulses throughout the year, with the highest median values observed in February and December (Fig. 38). Standardised CPUE indices also fluctuated throughout the year in square 15 75, with the highest median value observed in April. In square 15 70, standardised CPUE indices also appeared to increase and decrease in slow periodic waves as the months progressed: median values peaked slightly in January, June, and October. In the northeast square 15 65, values appeared to be fairly constant throughout the year; the lowest median value was observed in June, and the highest in November. In addition, a very high individual value was obtained in August. A similar trend was observed in the adjacent square 15 60; in this case, the highest median was observed in October, but the lowest median was again in June.

In the southwest squares 10 75 and 10 70, standardised CPUE indices showed no distinct monthly variation, but tended to be a little higher during January-June in 10 75 and during March-June in 10 70. In 10 70, however, the highest median value was observed in December (Fig. 38). In square 10 60 lying in the southeast, values fluctuated throughout the year showing no distinct monthly trend; the highest median value was observed in February. In the adjacent square 10 55, two peaks in median standardised CPUE were apparent: during February and also a lower peak during October. A similar trend was observed in square 10 50, in which case a very high value occurred in March and a comparativly high median value was observed in September. In the southernmost squares 05 55 and 05 50, the highest standardised CPUE indices were observed during the first and last few months of the year, with notably lower values obtained during the middle months.

<u>Purse Seine</u>

Yellowfin tuna

Sufficient data were available only for square 10 60, and box and whisker plots were constructed using data from the period 1971-1990. CPUE was estimated as kg/days fishing. Median standardised CPUE indices were highest during September-October and also in January (Fig. 39a). However, the range of individual values did not appear to differ much among months.

Skipjack tuna

Sufficient data were available only for square 10 60, and plots were constructed using data from the period 1971-1990. CPUE was estimated as kg/days fishing. Standardised CPUE indices showed no distinct monthly trend, but tended to be higher in January and during August-November (Fig 40a). In addition, very high individual values were observed in April and March.

Baitboat

Yellowfin tuna

Sufficient data were available only for square 10 60, and plots were constructed using data from the period 1971-1990. CPUE was estimated as kg/days fishing. Comparatively higher median standardised CPUE indices were observed during the latter months of the year, i.e. August-December. However, very high individual values occurred in January and February, as well as in November (Fig. 39b).

Skipjack tuna

Sufficient data were available only for square 10 60, and plots were constructed using data from the period 1971-1990. CPUE was estimated as kg/days fishing. Median standardised CPUE indices were markedly higher during the period January-April than during other months of the year (Fig 40b). A much smaller peak in median standardised CPUE was also observed in October.

DISCUSSION

Catch And Effort Trends

Market demand and changes in economy have influenced effort trends by large-scale fishing vessels operating in the region. For instance, Figs. 4 and 5 clearly show a decline in Japanese longline effort within the region during the late 1960s. Japanese longline operations began in the western equatorial Atlantic Ocean in 1956 with the target species being yellowfin tuna. Albacore tuna was targeted from about 1962. Both species were targeted for export to canneries. Since then, due to a change in economy and development of the super cold freezer ($<-50\ ^0C$) on board vessels, Japanese longliners shifted their effort to temperate waters and began targeting bluefin, southern bluefin and bigeye tunas in order to supply the higher priced domestic sashimi markets (Nakano, 1994a; Uozumi, 1994a, b). Similarly, Korean longliners began fishing in the region during the 1970s when they targeted mainly yellowfin tuna. A slight decrease in Korean longline effort was observed in the 1980s perhaps because during this period, these vessels began targeting bigeye tuna both in tropical and temperate waters (Anonymous, 1994a).

The longline catch data reflect the changes in Japanese and Korean longline operations, showing the predominance of yellowfin and albacore throughout the period of study but particularly in those catches taken during earlier years (1955-1970), and the greater presence of bigeye tuna in catches taken during later years (1971-1990) (Fig. 8). The contribution of billfish species to the catch may have been dependent on the catch rates of the targeted species and therefore the present data may not represent a true reflection of billfish abundance in the region. That is to say, billfishes may have been retained and not discarded only when catches of target species were low. This may explain why billfishes made up a more notable portion of the longline catches taken in north central and northwest squares.

Taiwanese longliners have operated in the region from around the mid-1960s (Fig. 4). Like the Japanese and Korean effort, Taiwanese effort has been fairly widespread throughout the region. However, until 1987, the main target species of the Taiwanese longline fleet has been albacore, after which effort was directed at bigeye and yellowfin tunas. It is therefore not surprising that albacore comprised a major portion of the catch in those squares, namely 15 55, and 15 60, where Taiwanese effort was greatest (Figs. 5 and 8). For U.S. longliners operating outside the Gulf of Mexico, swordfish has been the primary target species, with only small amounts of yellowfin taken. U.S. longline operations began in the Caribbean in the late 1980s. These vessels are believed to have come mainly from New England and fished in the Caribbean during the winter months, although vessels from Florida and the Gulf of Mexico may also be involved (Browder and Scott, 1992). The U.S. effort was most prevalent in squares south of Puerto Rico, with somewhat less effort directed in southern and northwestern squares. It is not surprising, therefore, that swordfish featured more strongly in longline catches taken during the later period, 1971-1990, and in those squares in which U.S. effort was greatest (Figs. 5 and 8).

Venezuela and Cuba commenced longline operations in the region in 1970 and 1975 respectively, with the majority of the effort observed in the 1980s. These operations have targeted mainly yellowfin (Anonymous, 1992). The Venezuelan vessels conducted most of their fishing in southeast squares close to Venezuela. In contrast, Cuban vessels conducted most of their longline operations in southeast squares off the coast of Guyana and east of the island chain. Hence, in squares 05 50, 05 55, 10 50, 10 55, and 10 60, even though different nations have conducted longline fishing during different periods, the main target species did not change. That is to say, throughout the entire period studied, yellowfin and albacore have remained the most important species in the catch in these squares (Figs. 5 and 8).

The majority of purse seine fishing operations in the region were conducted by U.S. and Venezuelan vessels. From the late 1960s to 1982, U.S. purse seine vessels fished for both yellowfin and skipjack in the Caribbean during their return from major fishing grounds in the eastern tropical Pacific and in the Gulf of Guinea in the eastern Atlantic, to unload their catch at canneries in Puerto Rico. Hence, the effort and magnitude of the Caribbean catches by these U.S. vessels depended on the success of Pacific and eastern Atlantic operations rather than on abundance of these fish in the Caribbean (Browder and Scott, 1992). It is interesting to note that in passing through the Caribbean, U.S. vessels were able to cover a large area, fishing in all squares but 15 55 and the north central and northwest squares 15 70, 15 75 and 15 85 (Fig. 6). U.S. purse seine operations in the Gulf of Guinea ceased in 1982, and U.S. purse seine effort in the Pacific shifted to the southwest Pacific after 1988. This explains the reduced U.S. purse seine effort observed in the Caribbean from 1982 onwards (Figs. 4 and 6).

Venezuela began purse seining operations in 1972, but effort and catches became important only after 1981 (Figs. 4b and 6). The majority of the Venezuelan fleet shifted effort to the eastern tropical Pacific during 1984-1988 (Anonymous, 1992), and this may explain the decline in effort observed in the Caribbean during that time. Since then, the Venezuelan purse seine fleet has split its effort between the western Atlantic and the eastern tropical Pacific, and annual variation in its effort and hence also catches in the Caribbean may have been dependent on catch rates in the eastern tropical Pacific. Both Venezuelan and U.S. purse seine vessels targeted mainly yellowfin and skipjack, and hence catches consisted of mostly these two species (Fig. 9). Furthermore, the purse seine gear is appropriate for targeting both yellowfin and skipjack since these warm-water species tend to inhabit the upper water column, usually above the thermocline. In the Caribbean, the 18^0 isotherm is known to occur at 150m and 200 m depth in southern and northern areas respectively, and hence in the south conditions would favour the the accessibility of the warm-water tunas to surface gear (Marcille, 1985).

Although Japanese baitboat vessels operated in the region during 1973-1975, the effort was low, and significant baitboat effort was only observed from 1983 onwards with the development of the Venezuelan baitboat fishery. Venezuelan baitboats operated mostly in southern squares, with some additional effort in the northeast squares 15 60 and 15 65 (Fig. 7). However, the greatest effort occurred in square 10 60 which was also the case for Venezuelan purse seine operations. This is not surprising, since in the south of the region, the thermocline is believed to occur at about 150 m, and hence as explained in the previous paragraph, certain tunas, especially, yellowfin and skipjack tuna, would be restricted to the upper water column and hence would be more easily caught by the surface gear. In addition, dissolved oxygen concentrations in southern Caribbean waters further restrict the vertical range of skipjack to 0-100 m (Marcille, 1985), and this may also explain why this species was so readily caught by the surface gear fisheries operating in the south. As might be expected, therefore, analysis of species composition of the baitboat catches showed that these catches consisted predominantly of skipjack and yellowfin tuna, with only small amounts of bigeye and other tunas sometimes present (Fig. 10).

Species Abundance

As previously mentioned, throughout the period, changes in target species by many fishing fleets have been driven largely by market demand and economy, as well as technological developments in gear and cold storage capabilities. In interpreting observed CPUE trends, therefore, notable market changes and technological developments are drawn to the reader's attention, as well as the possible influences of biological, ecological, and environmental factors to the extent that these are currently understood. Additional CPUE data and relevant research are required to confirm those interpretations provided regarding species biology and ecology, and the role of the environment.

Yellowfin tuna

The dramatic decline in Japanese yellowfin longline CPUE observed around the mid 1960s was most likely due to the fact that this fleet began to target albacore at that time, and hence may not reflect a true decline in yellowfin abundance (Fig. 11). It is interesting to note, however, that similar dramatic declines in Japanese longline CPUE were not evident in southwest squares. In the southwest, environmental conditions do not appear to favour albacore and bigeye concentrations (Singh-Renton and Neilson, 1994), and so a comparatively higher yellowfin CPUE may indicate a true higher abundance of yellowfin in this area compared to albacore and bigeye (Figs. 13-16).

For other nations which began fishing yellowfin with longline in later years, their CPUE indices were comparable to that of the Japanese during the same period, and showed similar declines. This is not surprising, since in the case of the U.S. and Taiwanese longline fleets, yellowfin was also not the target species. In those squares and years in which Venezuelan and Cuban longliners operated, their CPUE indices were comparable to those of other nations, despite the fact that yellowfin was the main target species. This may simply have been due to differences in fishing efficiency among the various fleets. On the other hand, if the Venezuelan and Cuban CPUE indices provide a true picture of yellowfin abundance, then this implies that although other nations' longline activities have targeted species other than yellowfin, any yellowfin catches were usually retained and not discarded. The Korean CPUE showed marked inter-annual variability, but also suggest that yellowfin abundance was generally lower during the 1980s.

In conclusion, therefore, the available longline CPUE indices suggest that yellowfin abundance was comparatively lower during the 1980s than in earlier years. Certainly, a separate analysis of U.S. longline yellowfin CPUE for the period 1982-1991 showed a decline in CPUE during 1988-1991 (Prager and Scott, 1994). In the eastern Atlantic, longline yellowfin CPUE also showed a similar decline to that of fleets operating in the western Atlantic (Anonymous, 1994b). Furthermore, recent production model analyses have confirmed that Atlantic yellowfin stock biomass has declined since 1970, and is currently slightly below the level at which Maximum Sustainable Yield (MSY) can be obtained (Anonymous, 1993, 1994b).

Areal differences in yellowfin abundance are indicated by comparatively lower CPUE indices in the northwest and in square 15 55 by Japanese and U.S. vessels. Similarly, Korean vessels obtained comparatively lower CPUE indices in square 15 55, east of the Leeward Islands. These results imply that yellowfin abundance is relatively lower and/or yellowfin is less accessible to longline vessels in these areas. Since CPUE indices in other northern squares are higher and are comparable to those recorded in the south, the reason for the apparent lower CPUE in square 15 55 is not clear. It is possible that environmental conditions are causing low abundance of yellowfin in certain northern squares. Research on the role of the environment in influencing tuna abundance in these areas may help to explain the apparent spatial differences.

Yellowfin tuna is also caught in surface waters with purse seine and baitboat gear. The present data indicate that in the Caribbean, purse seine and baitboat fisheries have operated mostly in southern areas. As discussed previously, since the thermocline occurs only at about 150 m depth in the south of the region, yellowfin may tend to swim closer to the surface and to be more accessible to surface gear in these areas. In squares 10 70 and 10 60, purse seine catches were higher than those taken by baitboats (Figs. 25 and 27). In addition, inter-annual variability in CPUE was often considerable. This is probably because the success of both purse seine and baitboat operations rely heavily on local environmental conditions which may differ with area and from year to year.

First of all, both types of operation proceed only after a tuna school of appropriate size is sighted. In addition, in the case of the purse seine, it is difficult to deploy the gear in very windy conditions with accompanying rough seas. On the other hand, success of the baitboat operation depends on whether the tuna school will feed at the time. The very high CPUE indices observed in some years in some areas may therefore be attributed to the presence of ideal environmental conditions for these operations. The surface fleet CPUE series for yellowfin were often short, making it difficult to identify trends in the data. In the case of the purse seine indices, no temporal trends were apparent. As noted previously, this may have been due to the fact that U.S. and Venezuelan purse seine vessels fished in the Caribbean only when their catches were low on their main fishing grounds in the eastern Pacific and eastern Atlantic Oceans. In contrast, baitboat CPUE appeared to increase with time, which may have been due simply to an increase in fishing efficiency as the fishery developed.

It is interesting to note that comparatively higher purse seine CPUE indices were observed in 10 60, while in the same square corresponding baitboat indices were lowest. This implies that local fishing conditions were better suited to purse seine gear than baitboat gear in targeting yellowfin tuna in this area. Apart from square 10 60, no other notable differences in CPUE among areas were observed, suggesting the existence of similar overall environmental conditions among the remaining squares fished. This is not unexpected since these squares all lie along the north and northeast coasts of South America.

The seasonal pattern observed suggests that some yellowfin aggregated in the southwest during the middle months of the year and in northern squares during the latter part of the year (Fig. 29). In contrast, abundance appeared to be fairly uniform throughout the year in southeast areas. Yellowfin larvae are found throughout the Caribbean all through the year, but appear to be most abundant in the southwest during the third quarter and in a large area east of the Antilles that includes squares 10 55 and 15 55 during the first two quarters (Capisano and Fonteneau, 1991; Cayré *et al.*, 1993). This implies that the southwest and east of the Antilles may be significant spawning areas, although it should be noted that the larval stage is believed to have a duration of 15 days, and currents may transport the larvae from a spawning site elsewhere to the southwest in a short period of time (Cayré *et al.*, 1993).

If, however, significant spawning does occur in the southwest Caribbean during the third quarter of the year, this would explain the peak in yellowfin CPUE observed in this area during the second and third quarters. That is to say, the peak may be due to the aggregation of yellowfin in reproductive condition in the southwest, in preparation for spawning. Similarly, in the eastern squares 10 55 and 15 55, sexually mature yellowfin would be expected to aggregate during January-June, although no marked peak in CPUE was observed in 10 55 during this time. Nonetheless, if these are significant spawning areas, then the peak observed in northern squares during the last 4-5 months of the year may be due to yellowfin dispersing away from the southwest and east of the Antilles after spawning is completed. Certainly, large yellowfin appear to be more abundant in catches taken by at least some eastern Caribbean islands during the last quarter of the year (P. Phillip, pers comm.; H. Guiste, pers comm.). The peaks in Korean CP observed in squares 10 60 and 05 55 during the latter half of the year may also be attributed migration of spent yellowfin away from the eastern spawning area (Fig. 30). More detai examination of Caribbean island CPUE indices, together with biological data on yellowfin in western Atlantic, should permit greater understanding of these observed patterns.

The purse seine and baitboat data presented for square 10 60 also showed a peak in CP during the latter half of the year (Fig. 39), supporting the notion that yellowfin are moving i this area following spawning activities east of the Antilles during the first half of the year. It also possible that purse seine CPUE tends to be lower during the first six months of the year a result of rougher seas caused by active northeast trade winds at this time, and therefore less th ideal conditions for deployment of this gear.

Albacore

The observed decline in Japanese albacore CPUE is most likely associated with the chan in target species from albacore to bigeye tuna by this fleet around 1970, and further accelerat with the introduction of the deep longline gear in 1980 (Fonteneau *et al.*, 1993). T corresponding Taiwanese CPUE indices were the highest observed, probably because albaco was the target species of the Taiwanese longline fleet during the period examined (Fig 1 Taiwanese CPUE declined more gradually in some of the squares fished than Japanese CPUE, a probably more accurately reflect the actual trend in albacore abundance. The comparatively low CPUE indices recorded by the U.S., Venezuela and Cuba were probably due to the fact th albacore was caught by these countries only as a by-catch species. From 1974 onwards wh Korean vessels operated in the area, their albacore CPUE indices decreased but were al generally lower than their yellowfin CPUE indices (Fig. 14), mostly because Korean vess targeted mainly yellowfin tuna until the beginning of the 1980s when the target species chang to bigeye tuna (Fonteneau *et al.*, 1993).

The declines in albacore CPUE observed in the Caribbean region are consistent with oth CPUE analyses for the stock throughout the rest of its range in the north Atlantic, north of 5° (Uozumi, 1994a, b, c; Anonymous, 1994c). Uozumi (1994b) showed that for the entire nor Atlantic, Japanese albacore CPUE dropped significantly after 1970, following a change in targ species. Uozumi (1994a) divided the Japanese albacore data for the north Atlantic into three tim periods, to accommodate for changes in target species and gear, and then estimated standardis CPUE indices for each period. A continual and substantial decrease in CPUE occurred duri each period. In the period 1959-1969 in which albacore was the principal target species, mea CPUE decreased from 178 kg/1,000 hooks in 1959 to about 2 kg/1,000 hooks in 1992. Naka (1994b) showed that Taiwanese albacore CPUE in the north Atlantic increased until around 197 then remained relatively stable until 1988 after which it decreased quite quickly. In compariso the Caribbean data showed that Taiwanese albacore CPUE tended to fluctuate about some consta level, in many of the squares fished, with definite but slight decreases observed in squares 15 5 and 10 60 and in the southwest. The differences in these results may simply reflect difference between local area and overall total stock abundance.

Regarding areal differences in CPUE, it is interesting to note that like yellowfin, albacore CPUE indices were comparatively lower in the northwest Caribbean. This result reinforces the view that environmental influences in northwest areas appear not to favour significant concentrations of some tuna species. Certainly, primary productivity has been found to be less in the northwest than in other parts of the Caribbean (Müller-Karger *et al.*, 1989). Additional research is needed to better understand the role of the environment in limiting albacore abundance in this area.

The seasonal patterns observed in Figs. 31 and and 32 appear to suggest that albacore abundance in some parts of the Caribbean is largely affected by changes in sea surface temperature. This is not unexpected since albacore is considered to be a temperate species preferring water temperatures of 15-21^{0}C (Collette and Nauen, 1983). Hence, in southern squares just off the coast of Venezuela and including southeast island EEZs (squares 10 75, 10 70, and 10 60), albacore CPUE was lowest during June-September when waters are warmest (Marcille, 1985). Although the signal was weaker, a similar drop in CPUE was observed during June-July in north central squares. In contrast, in the northeast Caribbean (square 15 60), albacore CPUE was highest during the first half of the year, with no marked drop during June-September. This seems to suggest that more than one factor may have contributed to the observed pattern in the northeast.

Firstly, the higher abundance observed during the first half of the year may have been due to albacore moving into the east Caribbean Sea from more temperate latitudes, a movement possibly helped by Atlantic inflow which is greatest at this time due to the influence of the northeast trade winds (Müller-Karger *et al.*, 1988). Although there are at present no additional Atlantic data to support this argument, notable correlation between peak catch rates by species and major current systems have been demonstrated for Japanese longline catch rate data from the Pacific Ocean (Nakamura, 1969). Secondly, relatively higher CPUE indices observed during May-August in the northeast (squares 15 65 and 15 60) and during August-September in north central areas (square 15 70) may have been due to albacore moving away from southern areas during this time. In squares 10 55 and 10 50 which lie east of the southeast islands, there did not appear to be a clear seasonal trend in albacore abundance, although high CPUE indices were sometimes obtained in July, August and September (Figs. 31 and 32). It is possible, therefore, that during the summer months, albacore may move into the north Caribbean and/or east into the western Atlantic in search of cooler water. Clearly, a full explanation of the observed CPUE patterns warrants species biological and ecological investigations in the Caribbean region.

The apparent lack of pattern in 05 55 and the February and May peaks in CPUE observed in 05 50 are difficult to interpret, since these patterns are somewhat different from those in adjacent squares and also since the northern and southern albacore stocks are separated at 5° N latitude. It is possible that these squares also received some albacore moving out of the Caribbean Sea during the warmer months of the year. Furthermore, these areas include the coastal waters of eastern Venezuela, Guyana, Suriname and French Guiana, and are directly affected, though differently, by upwelling action during the first half of the year and by river runoff throughout the year (Mahon, 1990; Müller-Karger *et al.*, 1988).

Due to its low dissolved oxygen content, cool upwelling water does not favour aggregation of albacore tuna. In addition, since tunas are visual predators (Singh-Renton and Neilson, 1994),

their feeding may be negatively affected by the large amounts of river water which are presen
these areas during the latter half of the year. The tunas are therefore likely to remain at the ed
of the plume fronts formed at the mouths of the Orinoco and Amazon rivers. Food spe
composition, and water salinity may also play a role in regulating albacore abundance, altho
further research is needed to fully explain the observed seasonal patterns.

Bigeye tuna

After 1980, both Japanese and Korean CPUE indices increased in most of the squa
fished. This was to be expected since at this time, these two fleets began to use deep longline g
to target bigeye tuna (Figs. 15 and 16). During the period studied, Venezuelan and Cuban ves
did not specifically target bigeye, and hence it is not surprising that the CPUE indices of th
vessels were comparatively lower than those of the Japanese which were recorded in similar u
On the other hand, it is interesting to note that even though bigeye was not a principal ta
species of U.S. longliners at the time, U.S. CPUE indices were at least comparable to Japan
CPUE indices in many of the squares fished, and were generally higher than those of other fl
during the short period when U.S. vessels operated in the region. It is possible that the size
bigeye caught by the two fleets were different, since small and medium bigeye tend to be cau
at shallower depths than the adults (Fonteneau *et al.*, 1993; Anon 1994d). It may also have b
due to the fact the U.S. longline fishery targeted swordfish, and therefore longlines were deplo
mainly at night when bigeye may have been closer to the surface. Although bigeye are not kn
to undergo diurnal vertical migrations in other parts of the Atlantic, such migrations may oc
This requires further investigation as it may have implications for access to this resource by sm
scale longliners.

The Caribbean data most likely reflect only the changes in gear and target species si
overall Atlantic longline CPUE, at least for the Japanese fleet, have declined gradually since 1
(Anonymous, 1994c). Recent bigeye assessments for the period 1961-1993 have confirme
steady decline in stock biomass (Anonymous, 1994c). In terms of spatial trends, CPUE
comparatively higher in south and southeast squares, and this is consistent with the belief that
part of the Caribbean sustains higher productivity (Singh-Renton and Neilson, 1994).

Although bigeye are believed to undertake trophic and reproductive migrations wh
appear to be seasonal, the extent and magnitude of these are not well known, and studies h
been limited to the eastern Atlantic (Bard *et al.*, 1993). Since it is assumed that all bigeye in
Atlantic belong to one stock (Anonymous, 1995), it is very likely that the seasonal trends obser
in the Caribbean are related to migratory patterns observed in the eastern Atlantic (Figs. 33
34). In north central and northwest squares, the seasonal pattern appeared to be bimo
(squares 15 65 and 15 75) and even trimodal (15 80 and 15 70). These squares lie en route
spawning and feeding grounds (Bard *et al.*, 1993), and the observed peaks occur at those tin
when the bigeye might be expected to pass through these areas. For instance, there is evide
that during the northern summer, bigeye move from equatorial areas to more northern latitu
for feeding purposes (Bard *et al.*, 1993). In addition, spawning is believed to take pl
throughout the year, but particularly during the first and third quarters of the year in a wide a
across the central tropical Atlantic (Cayré *et al.*, 1993). It is therefore likely that the obser

spatial and temporal differences in bigeye CPUE are related to specific feeding and spawning migrations. Biological studies on bigeye tuna are needed to provide a clearer understanding of the relationships between observed fish abundance in the Caribbean region and stock migratory habits involving a vast area of the Atlantic.

Billfishes

Billfish species are not targeted by the large -scale fishing fleets, and hence are caught only incidentally (Figs. 17-22 and 24). Furthermore, since they are by-catch, billfishes may often be discarded at sea to reserve storage space for target species. As a result, actual catches may have been under-reported. For these reasons, CPUE may not be an appropriate measure of species abundance in these cases. In consequence, the lack of distinct trends in CPUE during the period has to be interpreted with caution. Also, the comparatively higher CPUE indices obtained by the Japanese during the 1960s and 1970s may simply have been due to the fact that these fish are known to occur above the thermocline (Singh-Renton and Neilson, 1994), and therefore may have been more readily taken by the regular longline gear that reaches a depth of only 150 m, and which was used by the Japanese during this period. However, overall and many directed fishery CPUE series have shown a general decline in the abundance of each of these species (Anonymous, 1994e; Gaertner and Alió, 1994; Nakano *et al.*, 1994a, b). Recent assessments have also showed stocks to be currently at least fully exploited and likely over-exploited (Anonymous, 1994d, e).

Inter-annual variability was sometimes quite notable, and this may be at least partly attributed to the fact that these were not target species and therefore there would have been no need for fleets to attempt to maintain catches at any specific level. Regarding areal differences in CPUE, comparatively higher sailfish indices were observed in southeast and western squares along the continental margin. This is not surprising since sailfish is the least oceanic of the billfishes (Anonymous, 1988). In comparison, the more oceanic blue and white marlins were most commonly taken in northern squares, and in the case of white marlin, also along the eastern island chain. Although these areal differences are relatively small, the distribution of these fish are known to be influenced by currents, bottom topography, and possibly fronts (Anonymous, 1988). Hence, it is possible that local environmental conditions in the different areas contributed to the apparent higher abundance where observed.

In interpreting the seasonal trends, it is important to remember that since billfishes are by-catch, besides CPUE not being an accurate measure of abundance, the observed patterns may actually be driven by the seasonality of the target fisheries. That is to say, billfish catches may have become more important and may have been more readily retained (i.e. not discarded) by vessels during periods when target species were being caught in low quantities. For example, the peaks observed in sailfish CPUE during the summer months in southern squares may simply be caused by the apparent low abundance of albacore tuna in these areas during this time (Fig. 35). However, data from the artisanal fishery for billfish in Venezuela indicate that sailfish are highest in abundance off the Venezuelan coast during March-April and during June-November (Alió *et al.*, 1994). Observer data for Venezuelan longline operations targeting yellowfin and swordfish indicated higher catch rates for billfishes during September-February (Carter, 1994). In comparison, the recreational fishery in central Venezuela obtains the highest sailfish catch rates during September-November (Gaertner and Alió, 1994). Data from Barbados show that billfish are more abundant during the latter half of the year (Oxenford, 1994). The February pe observed in square 10 60 is supported by the Venezuelan data, as well as catch rate data fro Grenada (Mahon *et al.*, 1994). Furthermore, studies indicate that sailfish may undergo a nort south migration, related to seasonal changes in water temperature (Bayley and Prince, 1994). T monthly patterns in CPUE observed in the present data also tend to support this moveme hypothesis.

Blue marlin are believed to spawn in the northern Caribbean and near the Bahamas a Turks and Caicos Islands during the summer, mainly in July, and then again in Octob (Anonymous, 1994e). This may explain the higher CPUE indices observed in these months squares 15 60, and 15 65 compared to southern squares (Fig. 36). Square 15 70 also show higher CPUE indices during September-October, although no July peak was observed. Squa 15 75 did not show the July and October peaks, but this may be due to too few data points (s Fig. 36). For southern squares west of Grenada and Trinidad and Tobago, higher CPUE indic were observed during the last and first quarters of the year, extending from November to June square 10 70. This is consistent with the seasonal abundance indices obtained by sever Venezuelan fisheries operating off the central coast of Venezuela (Gaertner and Alió, 199 Carter, 1994; Alió *et al.*, 1994; Salazar and Marcano, 1994). These results suggest that duri the summer months, blue marlin may have migrated from southern squares towards spawni grounds in the north. In the southern areas east of Trinidad and Tobago and Barbado comparatively lower CPUE indices were also apparent in the summer months, although the patte is considerably weaker. In addition to spawning activities, changes in seasonal abundance appe to be related to weather patterns. That is to say, as in the case of sailfish, there is evidence th blue marlin remains in the Caribbean and western tropical Atlantic during the winter month moving north during the warm summer months (Bayley and Prince, 1994). This migration patte is similar to that observed for spawning, and hence is also supported by the present data.

Like blue marlin, white marlin is believed to undergo a north-south migration associat with similar seasonal changes in water temperature (Anonymous, 1994e). In addition, t available data suggest that white marlin spawn during April-June in the Caribbean and tropic western Atlantic (Anonymous, 1994e; Gaertner and Alió, 1994). The peak in CPUE observ during March-June in square 15 65 may therefore reflect a concentration of white marlin in th area for spawning, or en route to more northern latitudes with the approaching summer mont (Fig. 37). In southeast areas east of and including the square 10 60, CPUE tended to be lowe during June-July and highest during November-March. The data for white marlin thus suppo the hypothesis of a north-south migration, related to seasonal water temperature changes. On t other hand, the May-September and July-December peaks in CPUE observed in southwest squar 10 75 and 10 70 respectively suggest that not many white marlin leave southern areas during t spring and summer months. If so, then this implies that at least for white marlin, spawni readiness may be a more important determinant of the possible north-south migration rather tha simply changes in water temperature.

Swordfish

During the period studied, swordfish was the main target species of only the U.S. longline fleet and some Venezuelan longliners. Unfortunately, the U.S. data did not span many years and Venezuelan catches were very low during the period studied. Hence it is not possible to discuss changes in swordfish CPUE with time based on the present data for the Caribbean. For this reason, the data have not been plotted. The lack of a distinct trend, as well as marked inter-annual variability, in the Korean CPUE indices is probably due to the fact that swordfish was a by-catch species for this fleet (Fig. 23). This is because recent analyses of north Atlantic CPUE data have indicated a significant decline in swordfish stock biomass mainly due to a decline in numbers of larger fish (age 5+) as a result of over-exploitation (Anonymous, 1994c; Scott and Bertolino, 1995; Nakano, 1995; Mejuto and De La Serna, 1995).

No consistent trends were observed in monthly CPUE patterns among adjacent squares, likely owing to the very low catch rates obtained by most of the fleets. In southeast areas east of square 10 60, a weak bimodal pattern was obtained with the two peaks occurring during the first and last quarter of the year. Carter (1994) also recorded comparatively higher swordfish catch rates at this time of year by Venezuelan longliners which operated during 1987-1992. There is evidence that in the northwest Atlantic, swordfish spawn mainly during December-February within the latitudinal range of 19-23 °N, and also during May-June at higher latitudes (Arocha and Lee, 1995). If this is true, then sexually mature swordfish present in the southern Caribbean might be expected to migrate to these spawning areas at this time of year. The CPUE peak observed in the southern Caribbean during the first quarter may therefore reflect a higher abundance of immature fish. Carter (1994) obtained some size information on the Venezuelan swordfish catches, but the samples were small and the observed differences did not appear to be significant.

Skipjack tuna

This species is normally caught with purse seine and baitboat gear. As discussed for yellowfin, the thermocline occurs only at about 150 m depth in the south of the region, and hence skipjack may tend to occur closer to the surface and to be more accessible to surface gear in these areas. In addition, the vertical distribution of skipjack is known to be limited by dissolved oxygen which reaches the minimum level for this species (2.5-3.5 ml/l) at about 100 m depth in southern areas (Singh-Renton and Neilson, 1994).

Purse seine catches were generally higher than those taken by baitboats, and this is likely due to differences in efficiency of the two types of gear. In addition, inter-annual variability in CPUE was often marked (Figs. 26 and 28). As mentioned previously, this is probably because the success of both purse seine and baitboat operations rely heavily on prevailing environmental conditions which may differ in time and space. In consequence, the skipjack CPUE indices could be interpreted using the same arguments as for yellowfin purse seine and baiboat data.

Skipjack CPUE showed no distinct trends with time. This is consistent with observations on other west Atlantic CPUE data recently examined (Anonymous, 1994c). On the other hand, skipjack CPUE has shown a notable increase in recent years in the east Atlantic. However, the cause of this remains unclear because present data are insufficient to quantitatively assess the s (Anonymous, 1994c). Areal differences in CPUE did not appear to be significant, poss because environmental conditions were not notably different among the areas fished, which all found along the north and northeast coasts of South America.

It was possible to examine seasonal trends in square 10 60 only. In this square, pu seine CPUE indices were highest during January and August-October, while the highest bait CPUE indices occurred during January-April and in October. The two fisheries theref recorded their best catch rates during similar times of the year, except that the early year peak much more pronounced for baitboat operations. Again, due to the influence of the northeast tr winds in the Caribbean in the first part of the year, it is likely that sea conditions are not opti for purse seine operations at this time. On the other hand, the upwelling effect resulting fr wind action is thought to raise productivity levels in the area, and this may explain the high ca rates observed by baitboat vessels at the same time. Amazon water discharged during the la half of the year begins to reach the area at around the same time (Müller-Karger *et al.*, 1988), may also serve to increase the food supply for tunas as a result of enhanced primary productiv Certainly, results of migration studies suggest that skipjack movements are largely determined food availability, and that these fish migrate between zones rich in food for at least the first th years of life (Bard *et al.*, 1993; Stretta and Petit, 1992). Furthermore, skipjack may move i the area before the enrichment process is complete. The CPUE peaks observed during the th and beginning of the fourth quarters may therefore also be related to oceanic enrichment occurr in the area as a result of increased Orinoco discharges during the second half of the year and so Amazon discharges which can take up to a year to reach the area (Müller-Karger *et al.*, 198 If skipjack are in the area primarily for feeding purposes, then this also creates optimal conditio for use of baitboat gear. Pagavino and Gaertner (1994) also reported notably higher catches skipjack by Venezuelan baitboats in the first quarter of the year in the same area.

The preceding analysis of catch and effort data from ICCAT has provided the fi comprehensive view of large-scale offshore fishing for large pelagic fishes in the EEZs of seve CARICOM Member States. Despite the relatively large spatial scale of aggregation of the da it has been possible to resolve spatial, seasonal and inter-annual patterns for most of the maj species. The data have shown where and when large offshore fishing operations have be conducted in the Caribbean, and the nature of their catches.

The data have also provided indicative catch rates which can be used for planni purposes. For small-scale local fisheries, the data from the immediate square can be used as indication of what catch rates can be expected from different types of gear. However, sor differences can be expected with different vessesl, gear configuration and deployment, a proximity to shore. The observed patterns suggest, as indicated by a previous study southeastern Caribbean data (Mahon *et al.*, 1990), that catch rates have been highly variable fro year to year and with season. It is clear that additional biological studies are needed to provi a clearer understanding of the seasonal and spatial differences in species abundance.

The role of environment in determining the distribution and abundance of tunas is n clearly understood and few studies have been undertaken, particularly in the Caribbean (Maho in press). Some relevant environmental data exist in international databases, such as the U

National Oceanographic Data Center. However, although the data could be acquired, spatial and temporal coverage are highly variable for the Caribbean. Furthermore, considerable time and expertise are needed for analysis and interpretation of these data. Examination of oceanographic parameters, as well as species biology, and their effects on tuna distribution and abundance in the Caribbean region should be the focus of subsequent work.

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Table 1a. Fishing effort by gear type, effort type, nation and year in square 05 50

GEAR	LL						PS	
EFFORT	HOOKS/1,000						DAYS	
NATION	TAI	JAP	KOR	USA	VEN	CUB	USA	VEN
55	0	0	0	0	0	0	0	0
56	0	1	0	0	0	0	0	0
57	0	5	0	0	0	0	0	0
58	0	613	0	0	0	0	0	0
59	0	414	0	0	0	0	0	0
60	0	297	0	0	0	0	0	0
61	0	45	0	0	0	0	0	0
62	0	451	0	0	0	0	0	0
63	0	426	0	0	0	0	0	0
64	0	820	0	0	0	0	0	0
65	0	705	0	0	0	0	0	0
66	0	445	0	0	0	0	0	0
67	0	82	0	0	0	0	1	0
68	40	87	0	0	0	0	4	0
69	0	184	0	0	0	0	0	0
70	109	77	0	0	18	0	0	0
71	432	316	0	0	67	0	0	0
72	0	54	0	0	1	0	8	0
73	0	0	0	0	294	0	0	0
74	0	69	107	0	256	0	1	0
75	0	9	230	0	0	5	5	0
76	0	207	314	0	0	64	0	0
77	0	17	441	0	0	97	2	0
78	0	0	101	0	0	56	33	0
79	0	10	326	0	0	0	5	0
80	0	0	100	0	0	29	2	0
81	0	77	245	0	28	143	32	0
82	0	438	12	0	29	119	0	0
83	0	115	64	0	327	0	0	0
84	0	122	69	0	634	4961	0	1
85	0	273	57	0	512	216	0	0
86	0	13	94	0	327	1661	2	2
87	0	2	0	6	66	1390	0	0
88	0	49	7	6	0	243	0	0
89	0	26	68	23	0	75	0	0

Table 1b. Fishing effort by gear type, effort type, nation and year in square 05 55

GEAR	LL					PS		BB	
EFFORT	HOOKS/1,000					DAYS		DAYS	LINES
NATION	JAP	KOR	USA	VEN	CUB	USA	VEN	VEN	VEN
55	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0
58	170	0	0	0	0	0	0	0	0
59	41	0	0	0	0	0	0	0	0
60	130	0	0	0	0	0	0	0	0
61	16	0	0	0	0	0	0	0	0
62	113	0	0	0	0	0	0	0	0
63	72	0	0	0	0	0	0	0	0
64	111	0	0	0	0	0	0	0	0
65	416	0	0	0	0	0	0	0	0
66	228	0	0	0	0	0	0	0	0
67	8	0	0	0	0	1	0	0	0
68	38	0	0	0	0	1	0	0	0
69	14	0	0	0	0	0	0	0	0
70	90	0	0	27	0	0	0	0	0
71	148	0	0	13	0	0	0	0	0
72	3	0	0	2	0	2	0	0	0
73	0	0	0	25	0	0	0	0	0
74	3	10	0	19	0	0	0	0	0
75	0	70	0	0	0	7	0	0	0
76	0	148	0	0	0	0	0	0	0
77	0	41	0	0	11	0	0	0	0
78	0	87	0	0	0	116	0	0	0
79	3	98	0	0	0	2	0	0	0
80	0	19	0	0	9	5	0	0	0
81	0	119	0	41	4	19	0	0	314
82	29	0	0	12	0	0	0	0	0
83	3	17	0	252	0	0	38	50	0
84	17	0	0	230	950	0	128	22	0
85	10	0	0	285	61	0	1	55	0
86	0	0	0	258	78	6	16	29	0
87	0	0	1	62	655	0	10	9	0
88	0	0	4	0	102	0	3	18	0
89	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

90	1303	0	0	48	0	0	11	0

89	0	0	5	0	0	0	5	6	0
90	0	0	3	0	0	9	9	16	0

Table 1c. Fishing effort by gear type, effort type, nation and year in square 10 50

GEAR	LL						PS		BB	
EFFORT	HOOKS/1,000						DAYS		DAYS	
NATION	TAI	JAP	KOR	USA	VEN	CUB	USA	VEN	JAP	VEN
55	0	0	0	0	0	0	0	0	0	0
56	0	1	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0
58	0	90	0	0	0	0	0	0	0	0
59	0	402	0	0	0	0	0	0	0	0
60	0	301	0	0	0	0	0	0	0	0
61	0	56	0	0	0	0	0	0	0	0
62	0	379	0	0	0	0	0	0	0	0
63	0	437	0	0	0	0	0	0	0	0
64	0	846	0	0	0	0	0	0	0	0
65	0	286	0	0	0	0	0	0	0	0
66	0	238	0	0	0	0	0	0	0	0
67	0	111	0	0	0	0	0	0	0	0
68	154	32	0	0	0	0	0	0	0	0
69	163	17	0	0	0	0	0	0	0	0
70	48	23	0	0	10	0	0	0	0	0
71	515	305	0	0	0	0	0	0	0	0
72	13	52	0	0	27	0	0	0	0	0
73	202	0	0	0	82	0	0	0	0	0
74	115	0	57	0	15	0	2	0	2	0
75	0	3	107	0	0	0	0	0	0	0
76	42	2	285	0	0	80	0	0	0	0
77	5	5	146	0	0	179	0	0	0	0
78	0	0	272	0	0	0	4	0	0	0
79	0	291	73	0	0	0	0	0	0	0
80	81	0	89	0	0	13	0	0	0	0
81	10	436	442	0	5	0	0	0	0	0
82	16	1077	125	0	0	165	0	0	0	0
83	0	126	547	0	52	0	0	0	0	0
84	17	229	335	0	288	1458	0	0	0	0
85	487	175	44	0	176	38	0	0	0	6
86	647	0	125	0	32	758	0	0	0	1
87	90	2	0	3	0	1467	0	0	0	3
88	802	0	7	9	0	36	0	1	0	0
89	0	31	12	2	0	0	0	0	0	0
90	1155	0	0	28	0	0	0	0	0	0

Table 1d. Fishing effort by gear type, effort type, nation and year in square 10 55

GEAR	LL						PS		BB		
EFFORT	HOOKS/1,000						DAYS		DAYS		LINES
NATION	TAI	JAP	KOR	USA	VEN	CUB	USA	VEN	JAP	VEN	VEN
55	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0
58	0	151	0	0	0	0	0	0	0	0	0
59	0	566	0	0	0	0	0	0	0	0	0
60	0	343	0	0	0	0	0	0	0	0	0
61	0	86	0	0	0	0	0	0	0	0	0
62	0	308	0	0	0	0	0	0	0	0	0
63	0	303	0	0	0	0	0	0	0	0	0
64	0	656	0	0	0	0	0	0	0	0	0
65	0	1269	0	0	0	0	0	0	0	0	0
66	0	407	0	0	0	0	0	0	0	0	0
67	0	265	0	0	0	0	1	0	0	0	0
68	105	151	0	0	0	0	1	0	0	0	0
69	9	30	0	0	0	0	0	0	0	0	0
70	162	69	0	0	107	0	0	0	0	0	0
71	88	106	0	0	11	0	0	0	0	0	0
72	0	17	0	0	31	0	3	0	0	0	0
73	0	0	0	0	119	0	0	0	2	0	0
74	641	13	77	0	84	0	1	0	0	0	0
75	0	5	168	0	0	0	0	0	0	0	0
76	0	2	421	0	0	0	2	0	0	0	0
77	0	0	362	0	0	0	0	0	0	0	0
78	181	0	167	0	0	0	12	0	0	0	0
79	0	27	205	0	0	0	2	0	0	0	0
80	0	0	102	0	0	2	0	0	0	0	0
81	0	3	782	0	40	14	6	0	0	0	165
82	0	219	25	0	0	22	0	0	0	5	0
83	0	59	273	0	16	0	0	16	0	85	0
84	36	212	34	0	118	1767	0	69	0	74	0
85	161	105	85	0	142	29	5	40	0	84	0
86	14	0	55	0	27	224	1	12	0	56	0
87	30	0	0	4	16	829	0	5	0	5	0
88	0	0	3	14	0	10	0	0	0	7	0
89	0	21	6	19	0	13	0	0	0	1	0
90	275	0	0	20	0	0	3	5	0	7	0

Table 1e. Fishing effort by gear type, effort type, nation and year in square 10 60

GEAR	LL						PS				BB
EFFORT	HOOKS/1,000						DAYS				DAYS
NATION	TAI	JAP	KOR	USA	VEN	CUB	USA	VEN	SPN	GHA	JAP
55	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0
58	0	29	0	0	0	0	0	0	0	0	0
59	0	42	0	0	0	0	0	0	0	0	0
60	0	15	0	0	0	0	0	0	0	0	0
61	0	28	0	0	0	0	0	0	0	0	0
62	0	170	0	0	0	0	0	0	0	0	0
63	0	27	0	0	0	0	0	0	0	0	0
64	0	34	0	0	0	0	0	0	0	0	0
65	0	257	0	0	0	0	0	0	0	0	0
66	0	876	0	0	0	0	0	0	0	0	0
67	13	37	0	0	0	0	1	0	0	0	0
68	291	121	0	0	0	0	3	0	0	0	0
69	8	89	0	0	0	0	0	0	0	0	0
70	16	4	0	0	17	0	0	0	0	0	0
71	21	16	0	0	2	0	0	0	0	0	0
72	11	8	0	0	38	0	16	0	12	0	0
73	0	0	0	0	56	0	2	0	0	0	14
74	26	17	54	0	47	0	1	0	0	0	143
75	0	15	0	0	0	25	5	0	5	0	27
76	0	0	31	0	0	0	27	0	0	0	0
77	0	0	8	0	0	0	34	0	0	0	0
78	71	0	479	0	0	0	62	0	0	0	0
79	2	0	279	0	0	0	56	0	0	0	0
80	0	0	43	0	0	0	6	0	0	83	0
81	0	0	33	0	167	0	134	0	0	0	0
82	0	0	16	0	0	136	0	0	0	0	0
83	27	0	9	0	331	0	0	88	0	0	0
84	42	0	0	0	827	0	0	487	0	0	0
85	85	0	37	0	785	0	38	150	0	0	0
86	0	0	7	0	173	0	4	120	0	0	0
87	0	0	0	48	544	0	0	143	0	0	0
88	0	0	0	153	0	0	0	63	0	0	0
89	0	5	0	81	0	0	0	51	0	0	0
90	0	0	0	33	0	0	7	90	0	0	0

Table 1f. Fishing effort by gear type, effort type, nation and year in square 10 70

GEAR	LL						PS		BB	
EFFORT	HOOKS/1,000						DAYS		DAYS	LINES
NATION	TAI	JAP	KOR	USA	VEN	CUB	USA	VEN	VEN	VEN
55	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0
58	0	4	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0
60	0	3	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0
62	0	31	0	0	0	0	0	0	0	0
63	0	214	0	0	0	0	0	0	0	0
64	0	179	0	0	0	0	0	0	0	0
65	0	69	0	0	0	0	0	0	0	0
66	0	296	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0
68	170	134	0	0	0	0	1	0	0	0
69	73	72	0	0	0	0	0	0	0	0
70	203	80	0	0	2	0	0	0	0	0
71	0	112	0	0	9	0	0	0	0	0
72	1034	63	0	0	2	0	1	0	0	0
73	123	0	0	0	0	0	3	0	0	0
74	705	130	45	0	2	0	1	0	0	0
75	129	63	0	0	0	2	1	0	0	0
76	395	33	0	0	0	0	5	0	0	0
77	90	21	107	0	0	0	3	0	0	0
78	0	17	200	0	0	0	6	0	0	0
79	139	0	102	0	0	0	3	0	0	0
80	75	0	0	0	0	0	6	0	0	0
81	0	0	0	0	0	0	50	0	0	36
82	25	14	7	0	0	0	0	0	0	0
83	0	0	7	0	0	0	0	15	0	0
84	0	120	0	0	0	0	0	89	28	0
85	0	67	107	0	135	0	7	3	7	0
86	7	128	0	0	0	0	5	2	2	0
87	0	66	0	3	0	0	2	8	2	0
88	0	0	0	39	0	0	0	0	1	0
89	0	48	0	9	0	0	0	0	0	0
90	0	0	0	4	0	0	6	19	24	0

Table 1g. Fishing effort by gear type, effort type, nation and year in square 10 75

GEAR	LL						PS		BB
EFFORT	HOOKS/1,000						DAYS		DAYS
NATION	TAI	JAP	KOR	USA	VEN	CUB	USA	VEN	VEN
55	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0
61	0	3	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0
63	0	672	0	0	0	0	1	0	0
64	0	596	0	0	0	0	1	0	0
65	0	185	0	0	0	0	0	0	0
66	0	351	0	0	0	0	0	0	0
67	0	34	0	0	0	0	0	0	0
68	47	111	0	0	0	0	2	0	0
69	34	98	0	0	0	0	0	0	0
70	0	371	0	0	24	0	0	0	0
71	0	813	0	0	0	0	0	0	0
72	859	183	0	0	0	0	0	0	0
73	0	435	0	0	0	0	0	0	0
74	21	431	62	0	0	0	0	0	0
75	106	427	0	0	0	49	1	0	0
76	357	134	0	0	0	0	2	0	0
77	0	165	78	0	0	0	2	0	0
78	0	9	91	0	0	0	2	0	0
79	0	0	13	0	0	0	3	0	0
80	56	4	0	0	0	0	6	0	0
81	0	19	19	0	0	0	7	0	0
82	27	362	8	0	0	0	0	0	0
83	0	619	3	0	0	0	0	0	0
84	0	347	0	0	0	0	0	0	0
85	0	325	10	0	5	0	2	0	0
86	0	206	0	0	0	0	0	5	0
87	0	28	0	10	0	0	0	3	1
88	0	45	0	10	0	0	0	0	0
89	0	169	0	4	0	0	0	0	0
90	0	0	0	8	0	0	12	0	0

Table 1h. Fishing effort by gear type, effort type, nation and year in square 15 55

GEAR	LL						PS
EFFORT	HOOKS/1,000						DAYS
NATION	TAI	JAP	KOR	USA	VEN	CUB	USA
55	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0
60	0	2	0	0	0	0	0
61	0	0	0	0	0	0	0
62	0	95	0	0	0	0	0
63	0	608	0	0	0	0	0
64	0	652	0	0	0	0	0
65	0	275	0	0	0	0	0
66	0	32	0	0	0	0	0
67	479	132	0	0	0	0	0
68	612	176	0	0	0	0	0
69	483	30	0	0	0	0	0
70	432	194	0	0	0	0	0
71	552	276	0	0	0	0	0
72	413	0	0	0	0	0	0
73	1749	0	0	0	0	0	0
74	808	3	15	0	0	0	0
75	479	0	44	0	0	0	0
76	135	0	297	0	0	0	0
77	89	0	79	0	0	4	0
78	790	0	205	0	0	0	0
79	316	0	11	0	0	0	0
80	251	0	0	0	0	0	0
81	259	0	12	0	0	0	2
82	635	0	158	0	0	0	0
83	763	0	16	0	0	0	0
84	1691	0	267	0	10	0	0
85	2493	0	67	0	26	0	0
86	1964	0	144	0	0	0	0
87	977	6	0	3	0	0	0
88	0	0	0	0	0	0	0
89	0	0	0	3	0	0	0
90	0	0	0	16	0	0	0

Table 1i. Fishing effort by gear type, effort type, nation and year in square 15 60

GEAR	LL						PS		BB	
EFFORT	HOOKS/1,000						DAYS		DAYS	
NATION	TAI	JAP	KOR	USA	VEN	CUB	USA	VEN	JAP	VEN
55	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0
61	0	5	0	0	0	0	0	0	0	0
62	0	396	0	0	0	0	0	0	0	0
63	0	213	0	0	0	0	0	0	0	0
64	0	297	0	0	0	0	0	0	0	0
65	0	191	0	0	0	0	0	0	0	0
66	0	954	0	0	0	0	0	0	0	0
67	307	32	0	0	0	0	0	0	0	0
68	474	161	0	0	0	0	0	0	0	0
69	130	15	0	0	0	0	0	0	0	0
70	246	151	0	0	4	0	0	0	0	0
71	199	227	0	0	2	0	0	0	0	0
72	271	3	0	0	3	0	0	0	0	0
73	427	0	0	0	2	0	0	0	9	0
74	506	49	15	0	12	0	0	0	21	0
75	387	0	0	0	0	18	0	0	0	0
76	384	0	56	0	0	0	1	0	0	0
77	178	2	96	0	0	13	0	0	0	0
78	209	0	326	0	0	0	4	0	0	0
79	234	0	134	0	0	0	5	0	0	0
80	409	0	0	0	0	0	2	0	0	0
81	317	0	51	0	1	0	6	0	0	0
82	336	0	98	0	0	0	0	0	0	0
83	387	0	11	0	0	0	0	0	0	0
84	361	0	36	0	28	0	0	4	0	0
85	535	0	392	0	282	0	0	0	0	5
86	507	0	78	0	13	0	0	0	0	0
87	419	0	0	259	0	0	0	0	0	0
88	0	0	0	204	0	0	0	0	0	0
89	0	0	0	92	0	0	0	0	0	0
90	0	0	0	34	0	0	0	0	0	0

Table 1j. Fishing effort by gear type, effort type, nation and year in square 15 65

GEAR	LL						PS	BB	
EFFORT	HOOKS/1,000						DAYS		
NATION	TAI	JAP	KOR	USA	VEN	CUB	USA	JAP	VEN
55	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0
57	0	2	0	0	0	0	0	0	0
58	0	38	0	0	0	0	0	0	0
59	0	39	0	0	0	0	0	0	0
60	0	73	0	0	0	0	0	0	0
61	0	3	0	0	0	0	0	0	0
62	0	402	0	0	0	0	0	0	0
63	0	551	0	0	0	0	0	0	0
64	0	178	0	0	0	0	0	0	0
65	0	187	0	0	0	0	0	0	0
66	0	827	0	0	0	0	0	0	0
67	0	42	0	0	0	0	0	0	0
68	753	48	0	0	0	0	0	0	0
69	306	12	0	0	0	0	0	0	0
70	114	17	0	0	25	0	0	0	0
71	179	315	0	0	12	0	0	0	0
72	151	0	0	0	4	0	0	0	0
73	612	6	0	0	22	0	0	0	0
74	311	22	53	0	11	0	0	3	0
75	535	0	31	0	0	22	0	0	0
76	220	11	62	0	0	0	0	0	0
77	231	2	105	0	0	2	0	0	0
78	109	0	156	0	0	0	6	0	0
79	187	0	421	0	0	0	0	0	0
80	22	0	26	0	0	0	3	0	0
81	166	0	57	0	0	0	2	0	0
82	168	0	35	0	0	0	0	0	0
83	0	0	0	0	0	0	0	0	7
84	0	0	0	0	0	0	0	0	0
85	0	0	324	0	502	0	0	0	0
86	29	4	10	0	13	0	1	0	0
87	0	0	0	228	0	0	0	0	0
88	0	0	0	126	0	0	0	0	0
89	0	0	0	131	0	0	0	0	1
90	0	0	0	26	0	0	0	0	0

Table 1k. Fishing effort by gear type, effort type, nation and year in square 15 70

GEAR	LL						PS
EFFORT	HOOKS/1,000						DAYS
NATION	TAI	JAP	KOR	USA	VEN	CUB	USA
	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0
60	0	207	0	0	0	0	0
61	0	25	0	0	0	0	0
62	0	122	0	0	0	0	0
63	0	351	0	0	0	0	2
64	0	73	0	0	0	0	0
65	0	24	0	0	0	0	0
66	0	251	0	0	0	0	0
67	0	2	0	0	0	0	0
68	755	14	0	0	0	0	0
69	361	0	0	0	0	0	0
70	127	1	0	0	4	0	0
71	0	107	0	0	0	0	0
72	61	64	0	0	0	0	0
73	0	0	0	0	0	0	0
74	184	0	28	0	0	0	0
75	369	7	0	0	0	98	0
76	30	11	0	0	0	0	1
77	28	0	0	0	0	0	0
78	60	0	200	0	0	0	0
79	49	0	100	0	0	0	0
80	65	0	0	0	0	0	0
81	81	0	3	0	0	0	0
82	16	0	2	0	0	0	0
83	0	0	0	0	0	0	0
84	0	7	0	0	0	0	0
85	0	0	182	0	89	0	0
86	0	2	0	0	0	0	0
87	0	0	0	1	0	0	0
88	0	0	0	52	0	0	0
89	0	0	0	82	0	0	0
90	0	0	0	17	0	0	0

Table 1l. Fishing effort by gear type, effort type, nation and year in square 15 75

GEAR	LL						PS
EFFORT	HOOKS/1,000						DAYS
NATION	TAI	JAP	KOR	USA	VEN	CUB	USA
55	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0
62	0	36	0	0	0	0	0
63	0	72	0	0	0	0	0
64	0	404	0	0	0	0	0
65	0	172	0	0	0	0	0
66	0	157	0	0	0	0	0
67	0	28	0	0	0	0	0
68	67	47	0	0	0	0	0
69	0	230	0	0	0	0	0
70	0	2	0	0	8	0	0
71	0	261	0	0	0	0	0
72	0	16	0	0	0	0	0
73	0	3	0	0	0	0	0
74	38	11	18	0	0	0	0
75	0	227	0	0	0	100	0
76	85	43	0	0	0	0	1
77	67	21	9	0	0	2	0
78	0	0	62	0	0	0	0
79	0	0	6	0	0	0	0
80	0	0	0	0	0	0	0
81	0	0	0	0	0	43	0
82	0	0	0	0	0	0	0
83	0	0	0	0	0	0	0
84	0	114	0	0	0	75	0
85	0	11	15	0	11	0	0
86	0	0	0	0	0	0	0
87	0	0	0	14	0	76	0
88	0	0	0	14	0	0	0
89	0	0	0	4	0	0	0
90	0	0	0	65	0	0	0

Table 1m. Fishing effort by gear type, effort type, nation and year in square 15 80

GEAR	LL			PS	
EFFORT	HOOKS/1,000			DAYS	
NATION	JAP	USA	CUB	USA	CAN
55	0	0	0	0	0
56	0	0	0	0	0
57	0	0	0	0	0
58	0	0	0	0	0
59	0	0	0	0	0
60	0	0	0	0	0
61	0	0	0	0	0
62	0	0	0	0	0
63	11	0	0	0	0
64	280	0	0	0	0
65	406	0	0	0	0
66	21	0	0	0	0
67	0	0	0	2	0
68	6	0	0	0	0
69	174	0	0	0	0
70	6	0	0	0	0
71	536	0	0	0	0
72	90	0	0	1	1
73	8	0	0	0	0
74	0	0	0	0	0
75	249	0	22	4	0
76	82	0	0	1	0
77	5	0	0	3	0
78	0	0	0	0	0
79	0	0	0	0	0
80	0	0	0	0	0
81	0	0	0	0	0
82	0	0	25	0	0
83	0	0	0	0	0
84	0	0	0	0	0
85	0	0	0	0	0
86	0	0	0	0	0
87	0	5	0	0	0
88	0	28	0	0	0
89	0	16	0	0	0
90	0	15	0	0	0

Table 1n. Fishing effort by gear type, effort type, nation and year in square 15 85

GEAR	LL			PS	
EFFORT	HOOKS/1,000			DAYS	
NATION	JAP	USA	CUB	USA	CAN
55	0	0	0	0	0
56	0	0	0	0	0
57	0	0	0	0	0
58	0	0	0	0	0
59	0	0	0	0	0
60	0	0	0	0	0
61	0	0	0	0	0
62	0	0	0	0	0
63	8	0	0	0	0
64	16	0	0	0	0
65	7	0	0	0	0
66	0	0	0	0	0
67	0	0	0	0	0
68	0	0	0	0	0
69	0	0	0	0	0
70	2	0	0	0	0
71	111	0	0	0	0
72	23	0	0	1	1
73	0	0	0	0	0
74	22	0	0	0	0
75	42	0	18	0	0
76	0	0	0	0	0
77	0	0	0	0	0
78	0	0	0	0	0
79	0	0	0	0	0
80	0	0	0	0	0
81	0	0	0	0	0
82	0	0	0	0	0
83	0	0	0	0	0
84	0	0	0	0	0
85	0	0	0	0	0
86	0	0	0	0	0
87	0	0	0	0	0
88	0	4	0	0	0
89	0	1	0	0	0
90	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 2a. Percent species composition by time period, gear and catch type for square 05 50

YEARS	55-70	71-90		
GEAR	LL	LL		PS
CATCH	WT	WT	NO	NO
BFT	0.1			
YFT	69.0	37.6	52.3	64.4
ALB	17.7	9.2	8.6	
BET	3.6	26.6	19.9	
SKJ				35.6
SAI	5.3	0.5	5.8	
BUM	1.2	1.0	2.9	
WHM	2.9	0.2	1.0	
SWO	0.2	1.6	2.2	
BIL		1.0	6.6	
OTH		22.2	0.7	

Table 2b. Percent species composition by time period, gear and catch type for square 05 55

YEARS	55-70	71-90				
GEAR	LL	LL		PS	3	3
CATC H	NO	WT	NO	WT	1	3
BFT						
YFT	659.9	57.4	64.2	56.8	48.0	
ALB	18.5	8.8	7.6	0.8	0.3	
BET	3.6	6.9	5.7	1.0	1.6	
SKJ				41.4	48.8	100.0
SAI	12.9	1.0	2.8			
BUM	1.1	0.6	1.9			
WHM	3.7	0.1	0.5			
SWO	0.2	0.2	2.4			
BIL		2.4	13.4			
OTH		22.5	1.4		1.3	

Table 2c. Percent species composition by time period, gear and catch type for square 10 50

YEARS	55-70	71-90			
GEAR	LL	LL		PS	BB
CATCH	NO	WT	NO	WT	WT
BFT	0.4				
YFT	54.5	36.5	28.0	55.6	50.4
ALB	31.7	24.3	42.9		
BET	6.8	30.3	18.6		14.8
SKJ				44.4	25.9
SAI	1.7	0.3	2.2		
BUM	1.5	0.7	2.3		
WHM	2.9	0.5	1.3		
SWO	0.3	0.7	1.5		
BIL		0.6	2.7		
OTH		6.1	0.6		

Table 2d. Percent species composition by time period, gear and catch type for square 10 55

YEARS	55-70	71-90				
GEAR	LL	LL		PS	BB	
CATCH	NO	WT	NO	WT	WT	NO
BFT	0.1					
YFT	49.1	49.7	45.5	52.6	30.1	1.9
ALB	32.5	19.2	25.3	0.5	0.2	
BET	6.3	21.3	13.9	3.6	2.4	
SKJ				43.2	66.9	98.1
SAI	5.1	1.5	1.6			
BUM	1.7	1.1	4.0			
WHM	4.8	0.4	2.9			
SWO	0.3	0.7	3.1			
BIL	0.1	1.4	3.4			
OTH		4.7	0.4	0.1	0.3	

Table 2e. Percent species composition by time period, gear and catch type for square 10 60

YEARS	55-70	71-90				
GEAR	LL	LL		PS	BB	
CATCH	NO	WT	NO	WT	WT	NO
BFT			0.1			
YFT	67.7	77.1	33.9	59.7	31.8	1.3
ALB	15.1	4.9	9.5	1.8	1.1	
BET	4.0	6.7	9.8	3.2	4.2	
SKJ				34.1	62.0	98.7
SAI	3.0	0.2	1.1			
BUM	1.8	0.2	2.2			
WHM	7.6	0.1	1.6			
SWO	0.7	0.5	37.3			
BIL		2.7	2.5			
OTH	0.1	7.5	2.0	1.2	0.9	

Table 2f. Percent species composition by time period, gear and catch type for square 10 70

YEARS	55-70	71-90				
GEAR	LL	LL		PS	BB	
CATCH	NO	WT	NO	WT	WT	NO
BFT		0.1	0.1			
YFT	55.0	68.1	62.8	47.5	91.8	13.7
ALB	25.2	12.1	20.5	5.4		
BET	3.9	8.6	4.8			
SKJ				46.8	8.2	86.3
SAI	3.5	0.4	0.6			
BUM	2.6	0.7	1.4			
WHM	9.0	1.0	7.1			
SWO	0.8	0.8	2.6			

Table 2g. Percent species composition by time period, gear and catch type for square 10-75

YEARS	55-70	71-90			
GEAR	LL	LL		PS	BB
CATCH	NO	WT	NO	WT	WT
BFT		0.5			
YFT	58.5	52.4	57.8	44.4	
ALB	16.3	24.2	11.1		
BET	8.6	10.5	17.3		
SKJ				55.6	100.0
SAI	6.3		3.7		
BUM	5.4	1.0	4.0		
WHM	4.1	1.0	3.4		
SWO	0.8	1.1	2.3		
BIL		1.5	0.2		
OTH		7.9	0.1		

Table 2h. Percent species composition by time period, gear and catch type for square 15 55

YEARS	55-70	71-90	
GEAR	LL	LL	
CATCH	NO	WT	NO
BFT	0.4		
YFT	12.2	31.2	5.6
ALB	80.4	51.6	90.7
BET	1.8	6.9	1.3
SKJ			
SAI	0.3	0.2	0.1
BUM	1.9	1.3	0.6
WHM	2.6	0.6	1.1
SWO	0.3	0.4	0.3

BIL	2.2	0.1	
OTH	5.9	0.1	0.3

BIL		0.5	
OTH	0.1	7.3	0.3

Table 2i. Percent species composition by time period, gear and catch type for square 15 60

YEARS	55-70	71-90			
GEAR	LL	LL		PS	BB
CATCH	NO	WT	NO	WT	WT
FT	0.4				
YFT	27.4	56.1	10.6		22.6
ALB	53.5	19.4	64.6		0.2
BET	2.4	15.2	2.1	100.0	
SKJ					77.2
SAI	1.4	0.3	0.4		
BUM	2.9	0.9	1.6		
WHM	11.3	1.3	7.7		
SWO	0.4	1.2	11.6		
BIL	0.1	0.9	0.9		
OTH	0.1	4.7	0.6		

Table 2j. Percent species composition by time period, gear and catch type for square 15 65

YEARS	55-70	71-90			
GEAR	LL	LL		PS	BB
CATCH	NO	WT	NO	WT	WT
BFT	0.1				
YFT	53.7	66.6	28.3	50.0	81.2
ALB	33.8	11.2	40.0		
BET	3.0	13.1	2.8		
SKJ				50.0	18.8
SAI	1.0	0.7	0.2		
BUM	4.2	0.6	1.9		
WHM	3.4	0.2	10.7		
SWO	0.6	1.8	15.6		
BIL	0.1	1.5	0.3		
OTH		4.3	0.2		

Table 2k. Percent species composition by time period, gear and catch type for square 15 70

YEARS	55-70	71-90	
GEAR	LL	LL	
CATCH	NO	WT	NO
BFT		0.1	
YFT	49.0	74.6	37.8
ALB	40.6	11.9	28.5
BET	2.6	7.6	4.0
SKJ			
SAI	0.8	0.5	0.4
BUM	4.4	1.0	3.7
WHM	1.8	0.4	5.4
SWO	0.6	1.1	17.7
BIL		0.6	1.8
OTH		2.1	0.7

Table 2l. Percent species composition by time period, gear and catch type for square 15 75

YEARS	55-70	71-90	
GEAR	LL	LL	
CATCH	NO	WT	NO
BFT			
YFT	28.6	46.9	24.8
ALB	26.1	31.6	28.1
BET	1.9	9.2	4.2
SKJ			
SAI	3.1	0.1	1.4
BUM	25.6	1.6	19.8
WHM	13.9		2.5
SWO	0.7	3.9	14.1
BIL		0.1	3.3
OTH		6.6	1.9

Table 2m. Percent species composition by time period, gear and catch type for square 15 80

YEARS	55-70		71-90
GEAR	LL	PS	LL
CATCH	NO	WT	NO
BFT	0.1		
YFT	8.4	100.0	13.3
ALB	21.8		16.1
BET	2.3		3.2
SKJ			
SAI	4.1		5.9
BUM	50.9		43.2
WHM	11.6		4.5
SWO	1.0		11.6
BIL			1.2
OTH			1.0

Table 2n. Percent species composition by time period, gear and catch type for square 15 85

YEARS	55-70	71-90
GEAR	LL	LL
CATCH	NO	NO
BFT		
YFT	26.3	10.7
ALB	15.6	1.4
BET	8.0	28.8
SKJ		
SAI	24.3	11.6
BUM	11.3	26.8
WHM	13.5	7.6

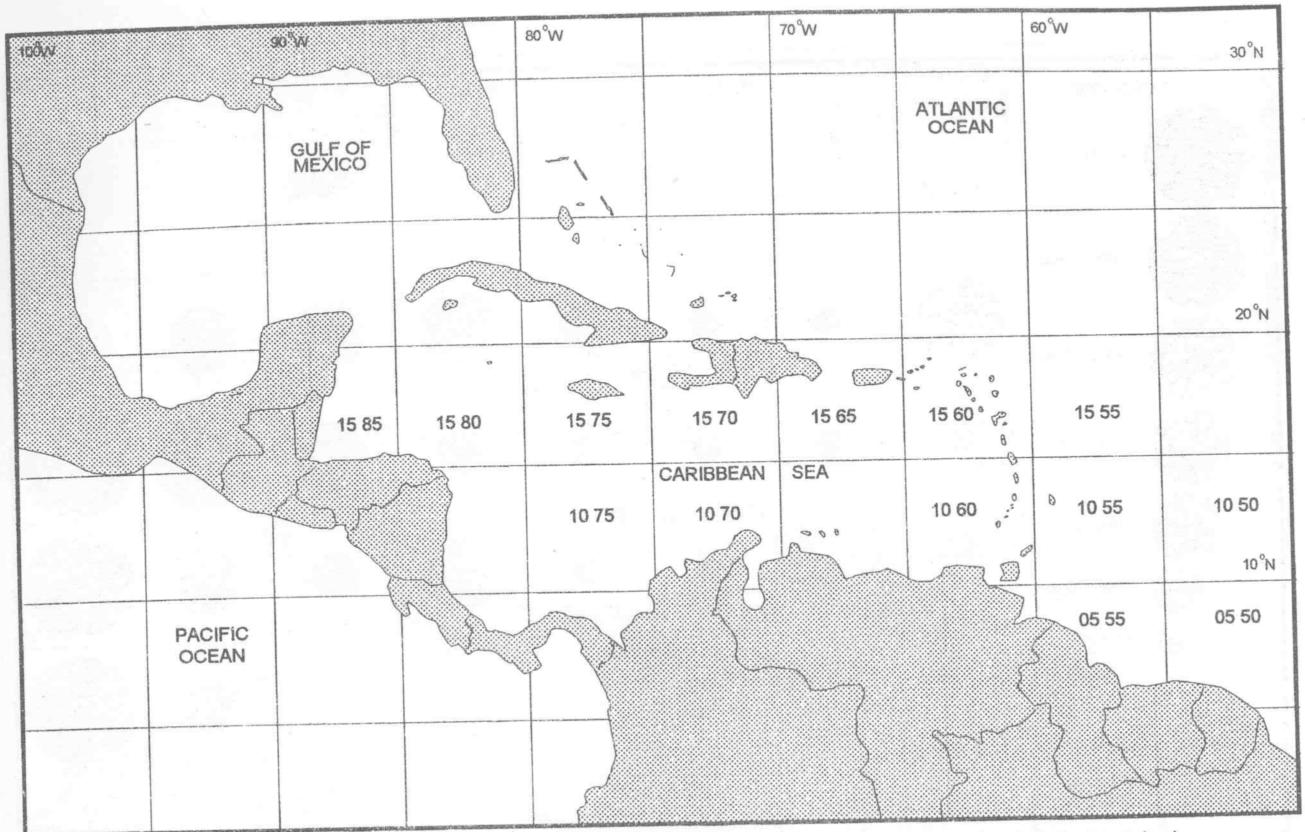

Figure 1. The Wider Caribbean Region showing 5 degree squares and those selected for detailed analysis (numbered by a four-digit code giving latitude and longitude coordinates respectively of the lower right corner of the square).

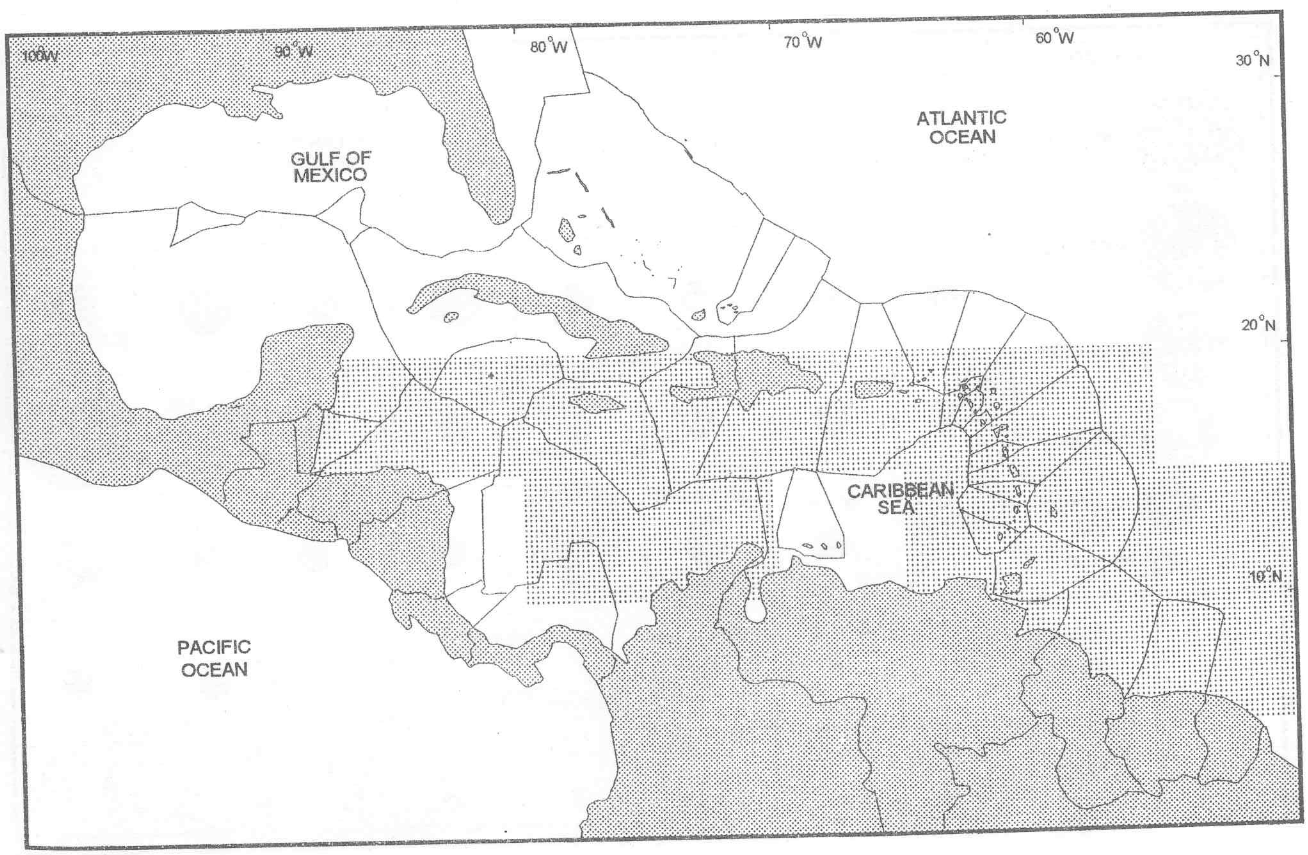

Figure 2. The EEZs of Caribbean countries and the squares selected for analysis (shaded)

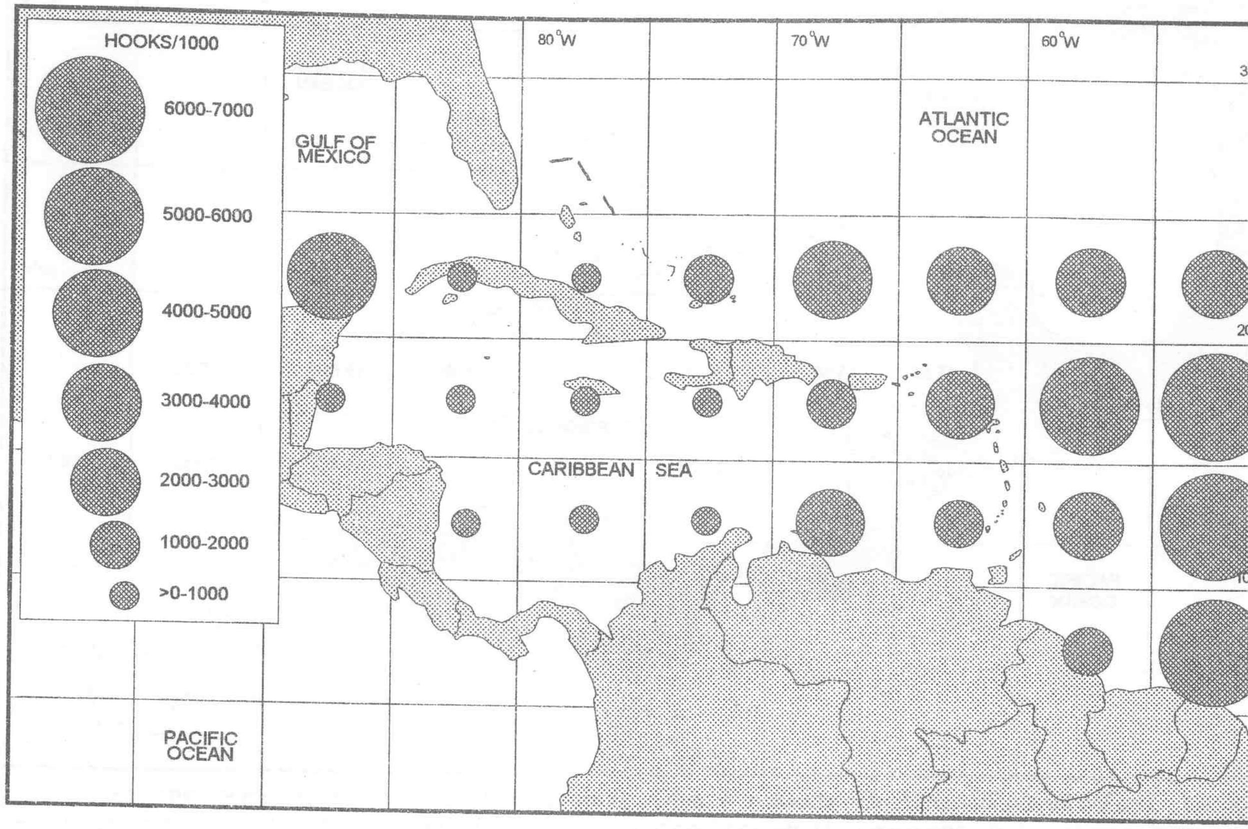

Figure 3a. Total effort by longliners, 1985-1990

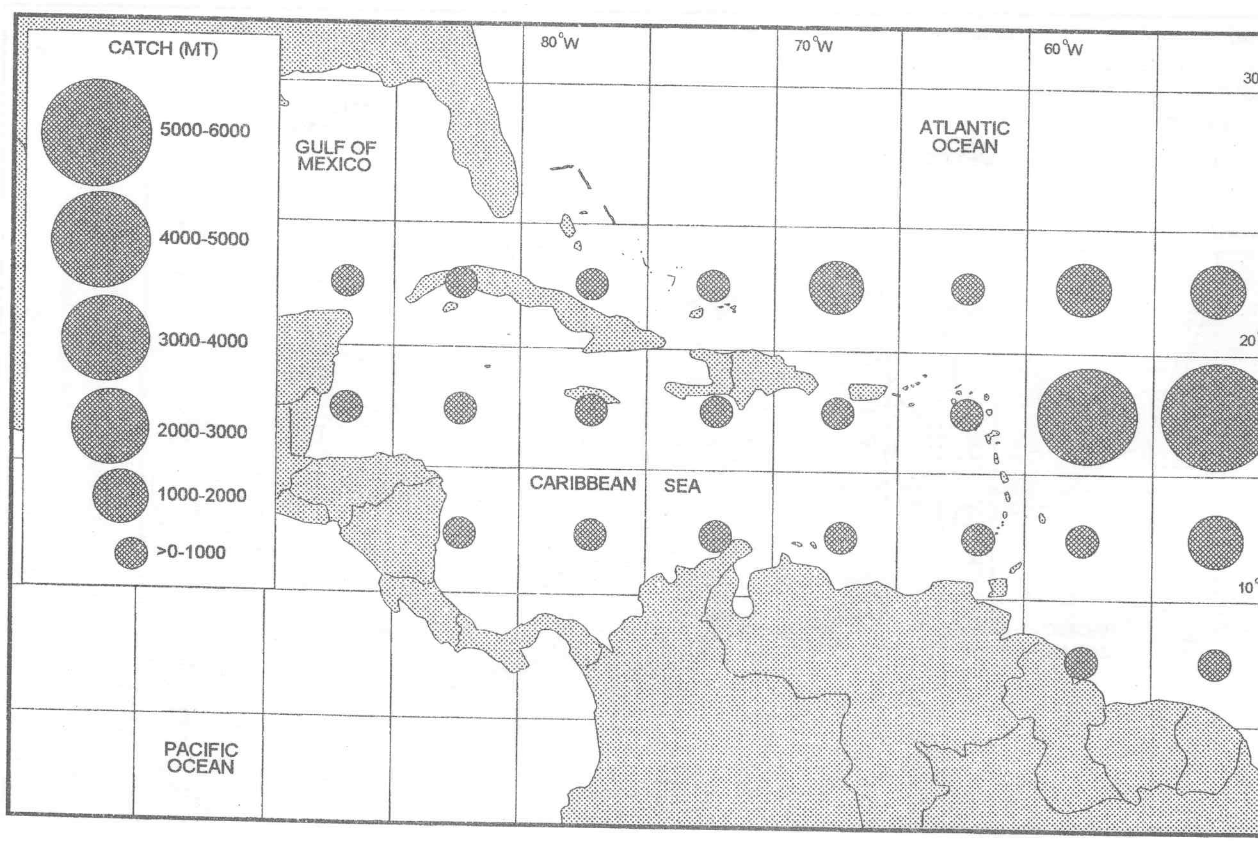

Figure 3b. Total catch (mt) by longliners, 1985-1990

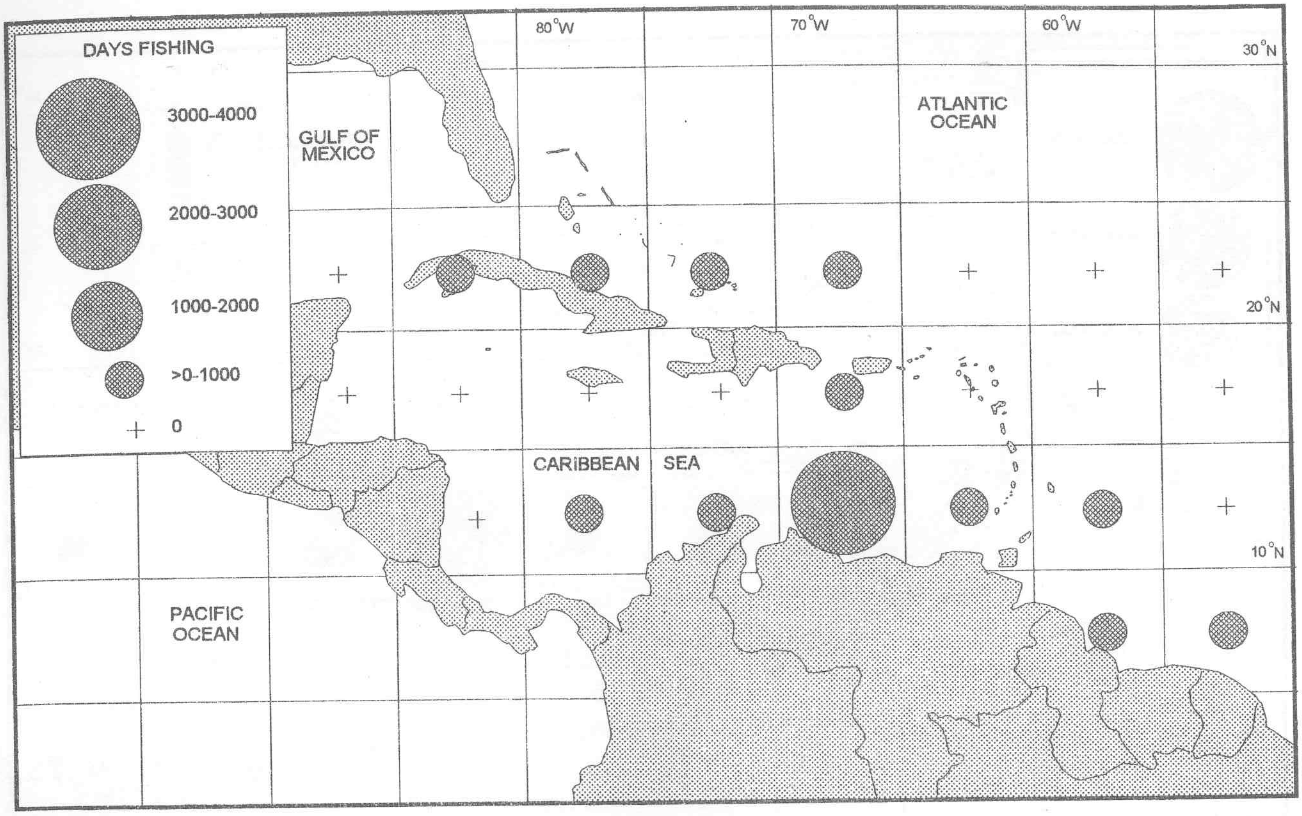

Figure 3c. Total effort (days fishing) by purse seiners, 1985-1990

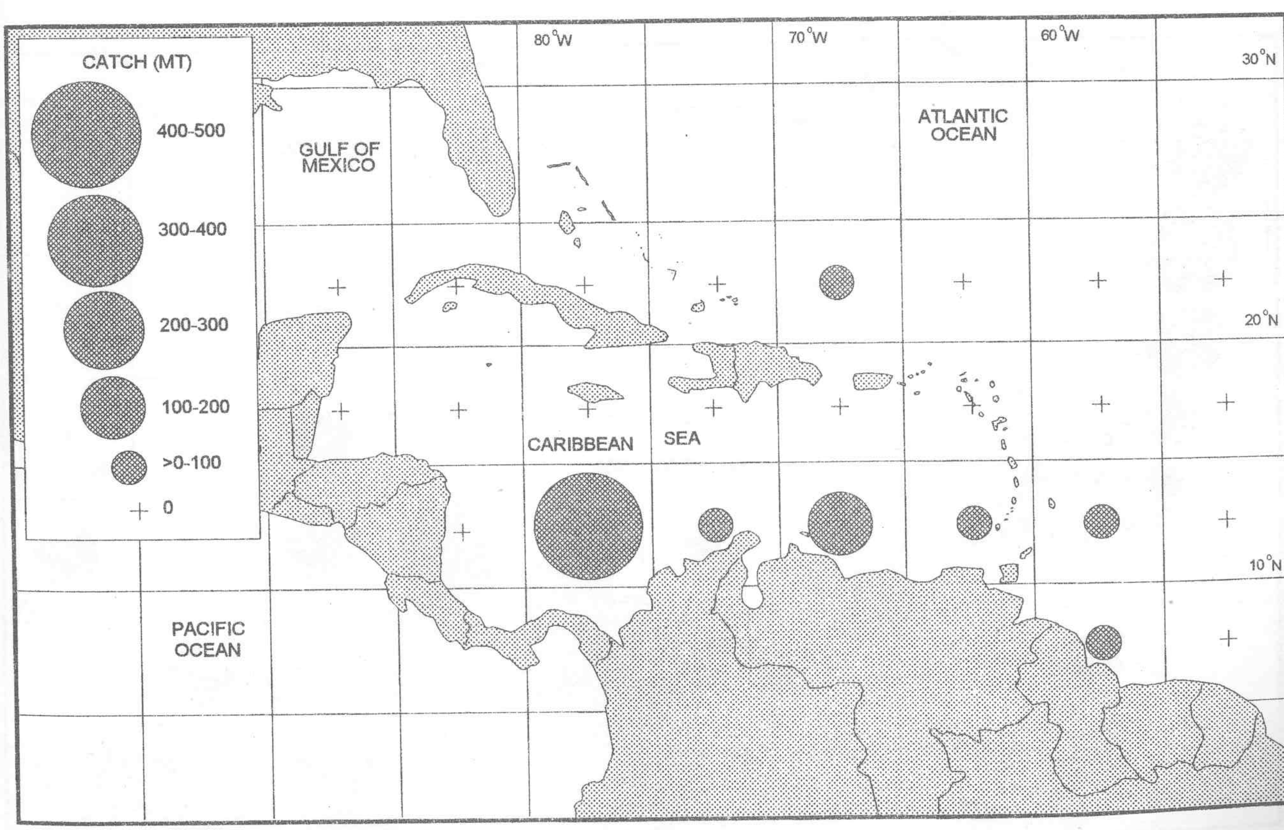

Figure 3d. Total catch (mt) by purse seiners, 1985-1990

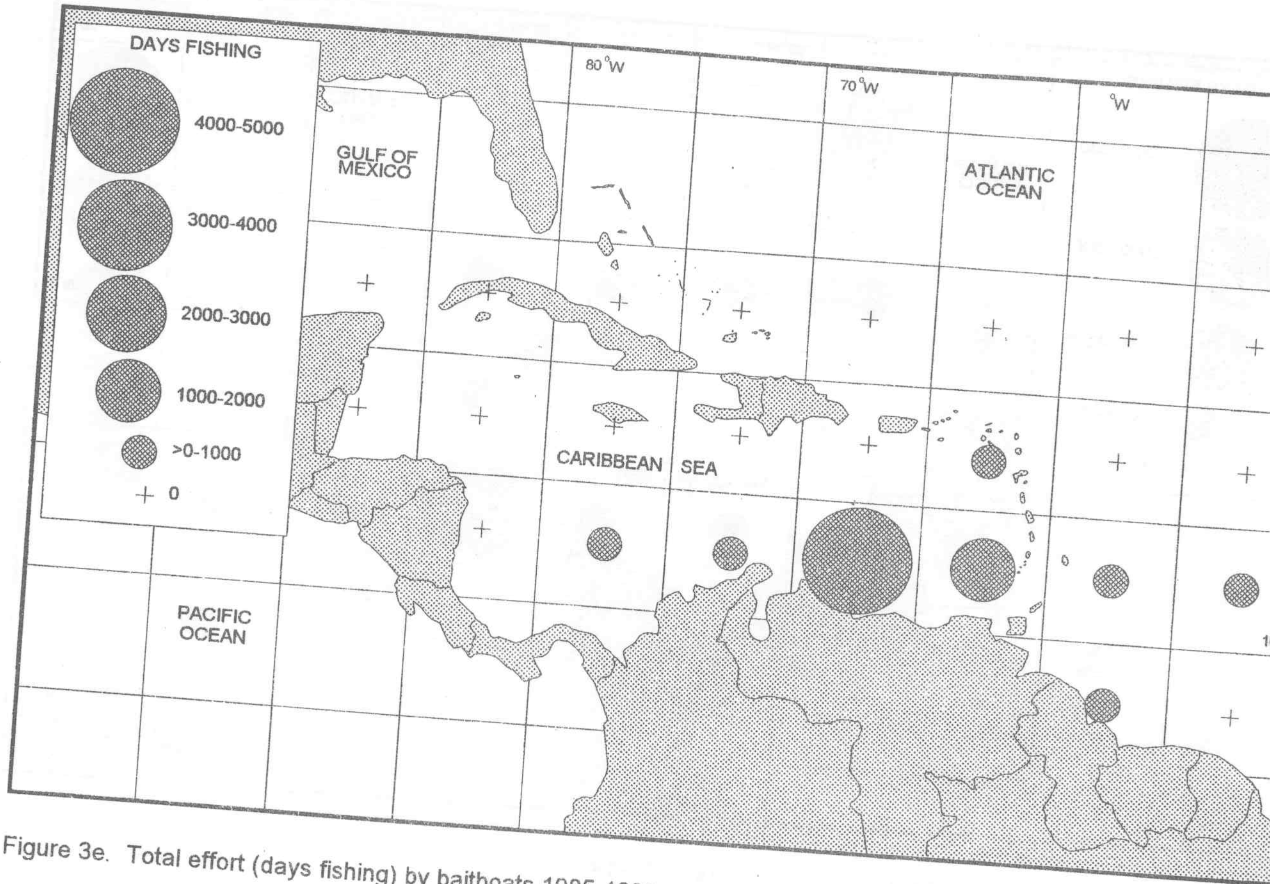

Figure 3e. Total effort (days fishing) by baitboats 1985-1990

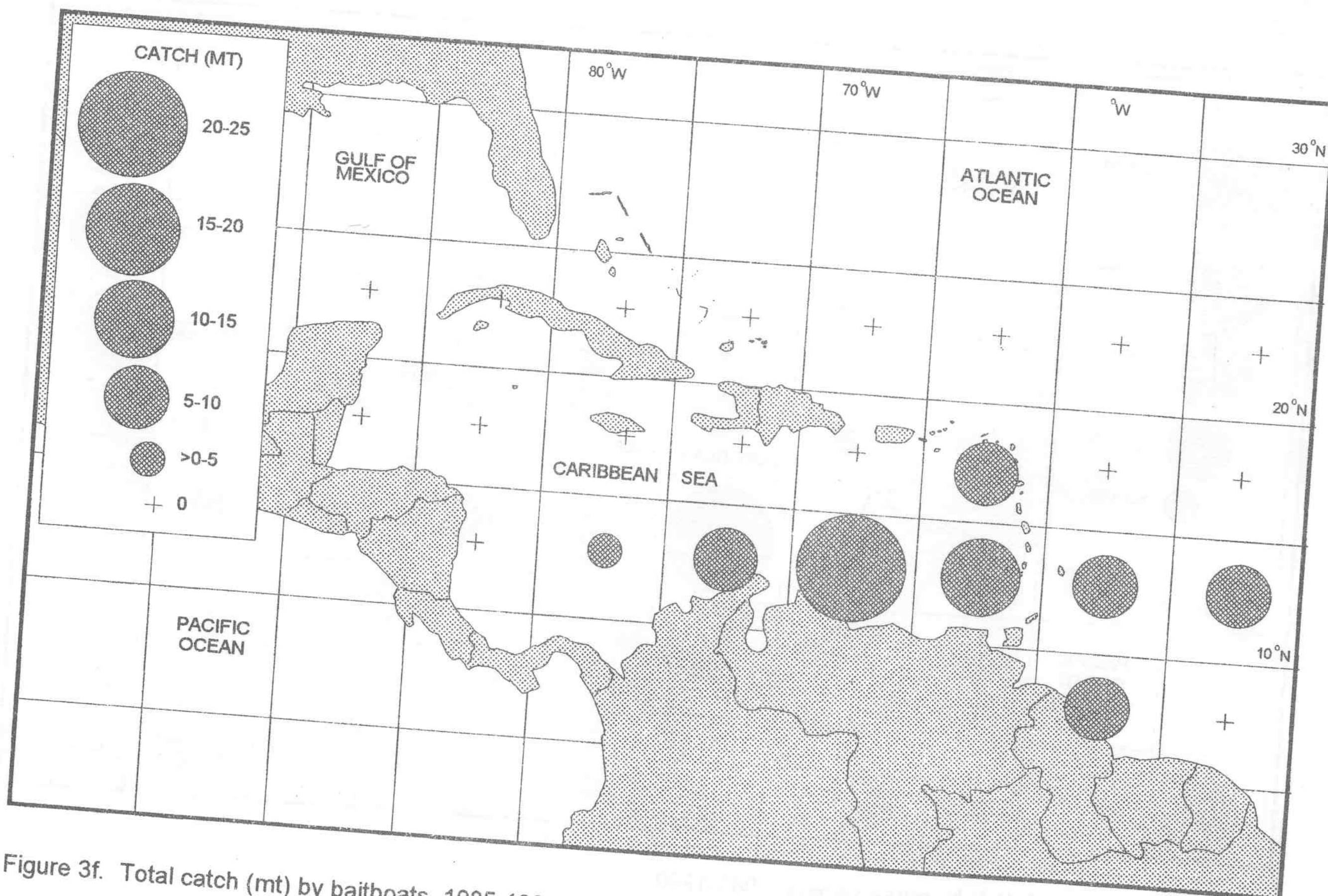

Figure 3f. Total catch (mt) by baitboats, 1985-1990

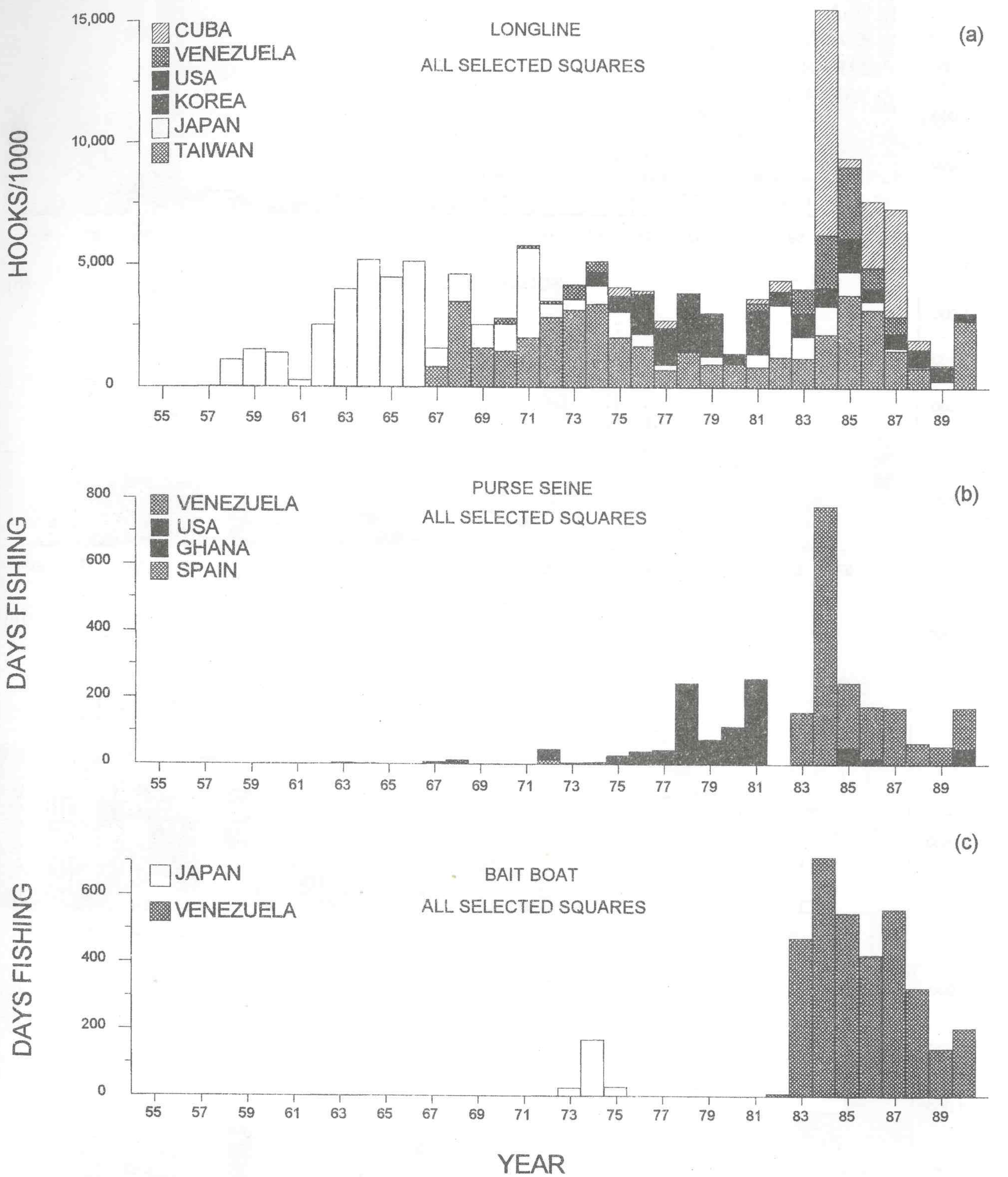

Figure 4. Fishing effort by gear and nation for all selected squares (bars are stacked in the same sequence as the key).

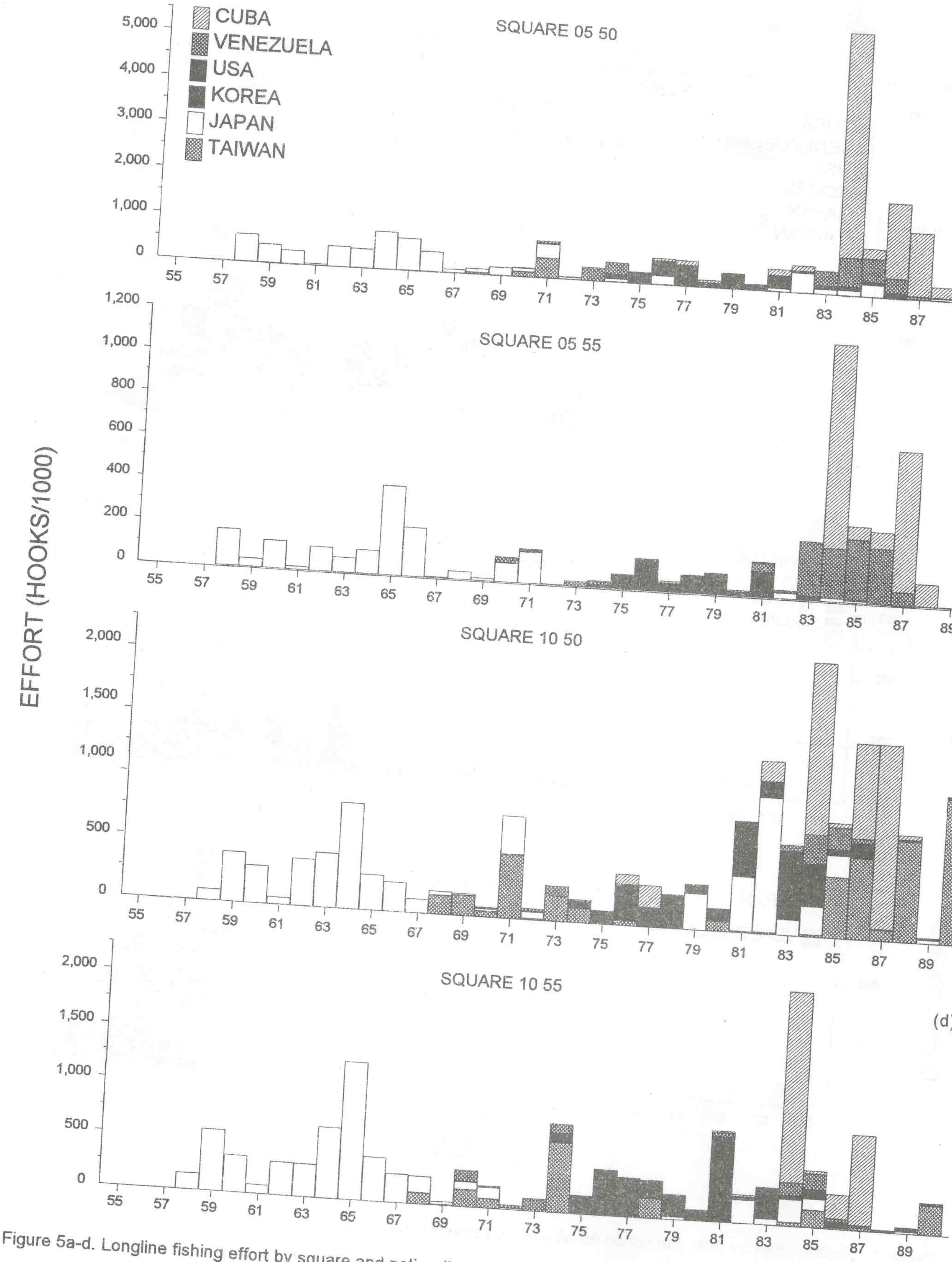

Figure 5a-d. Longline fishing effort by square and nation (bars are stacked in the same sequence as the key).

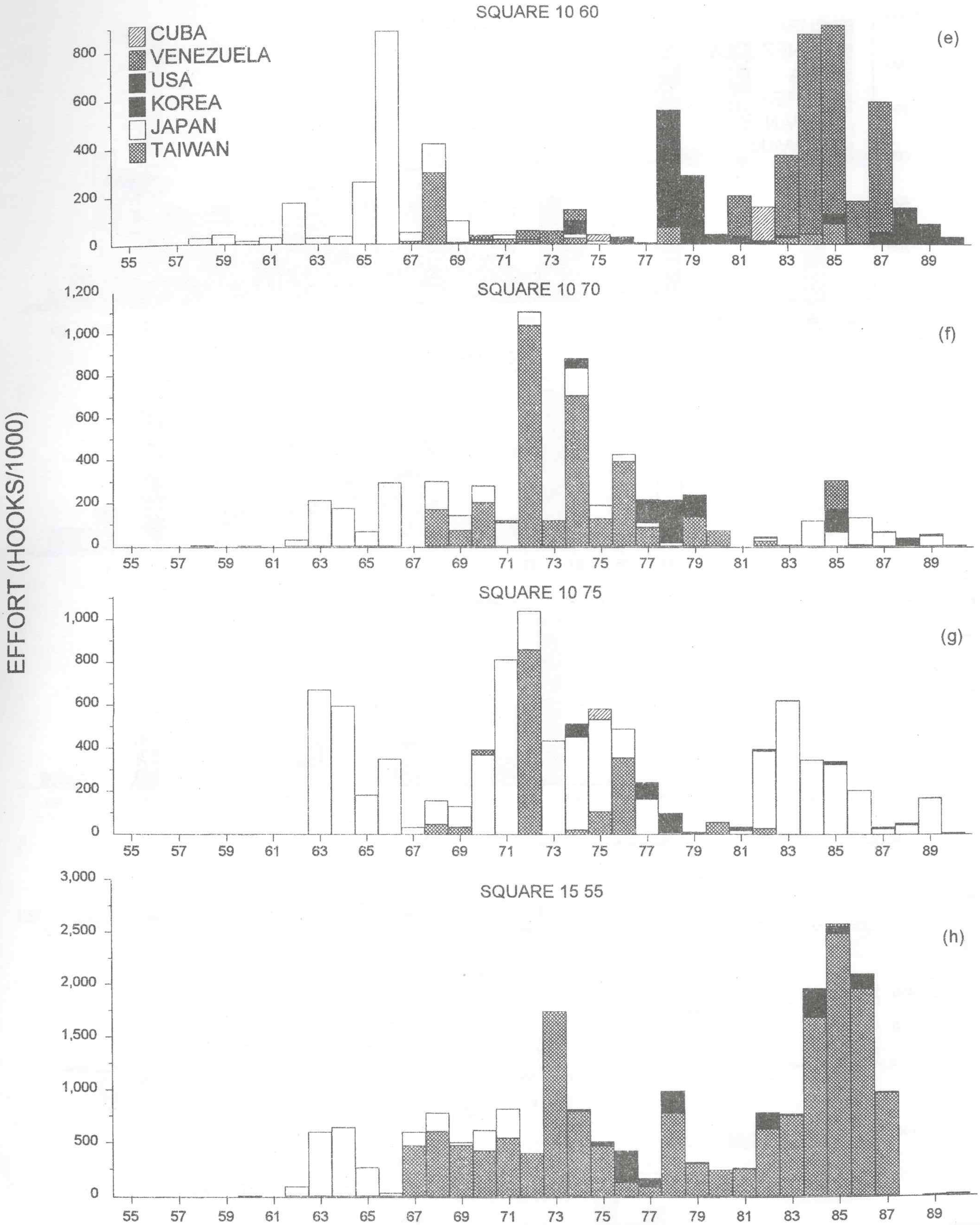

Figure 5e-h. Longline effort by square and nation (bars are stacked in the same sequence as the key).

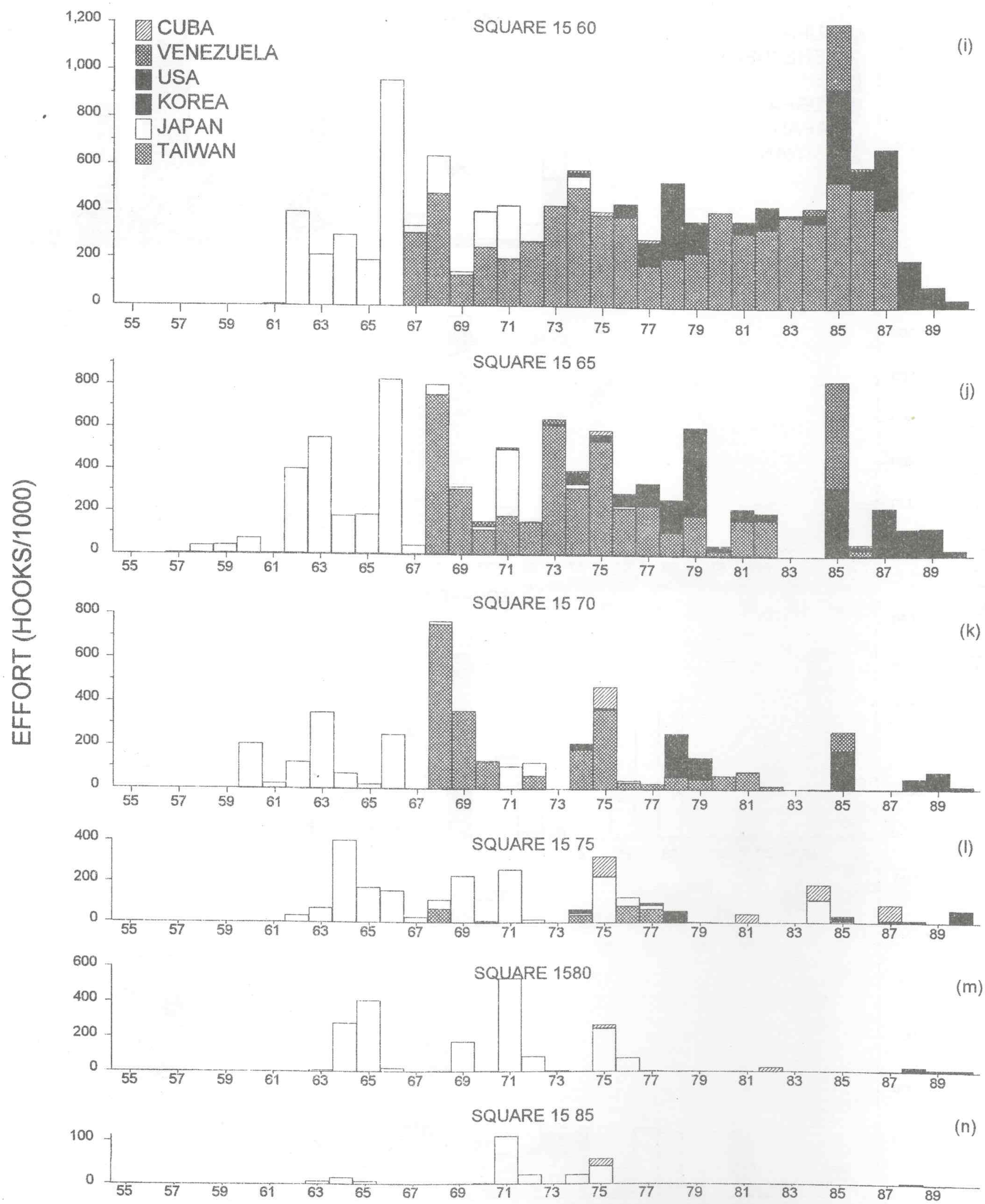

Figure 5i-n. Longline fishing effort by square and nation (bars are stacked in the same sequence as the key).

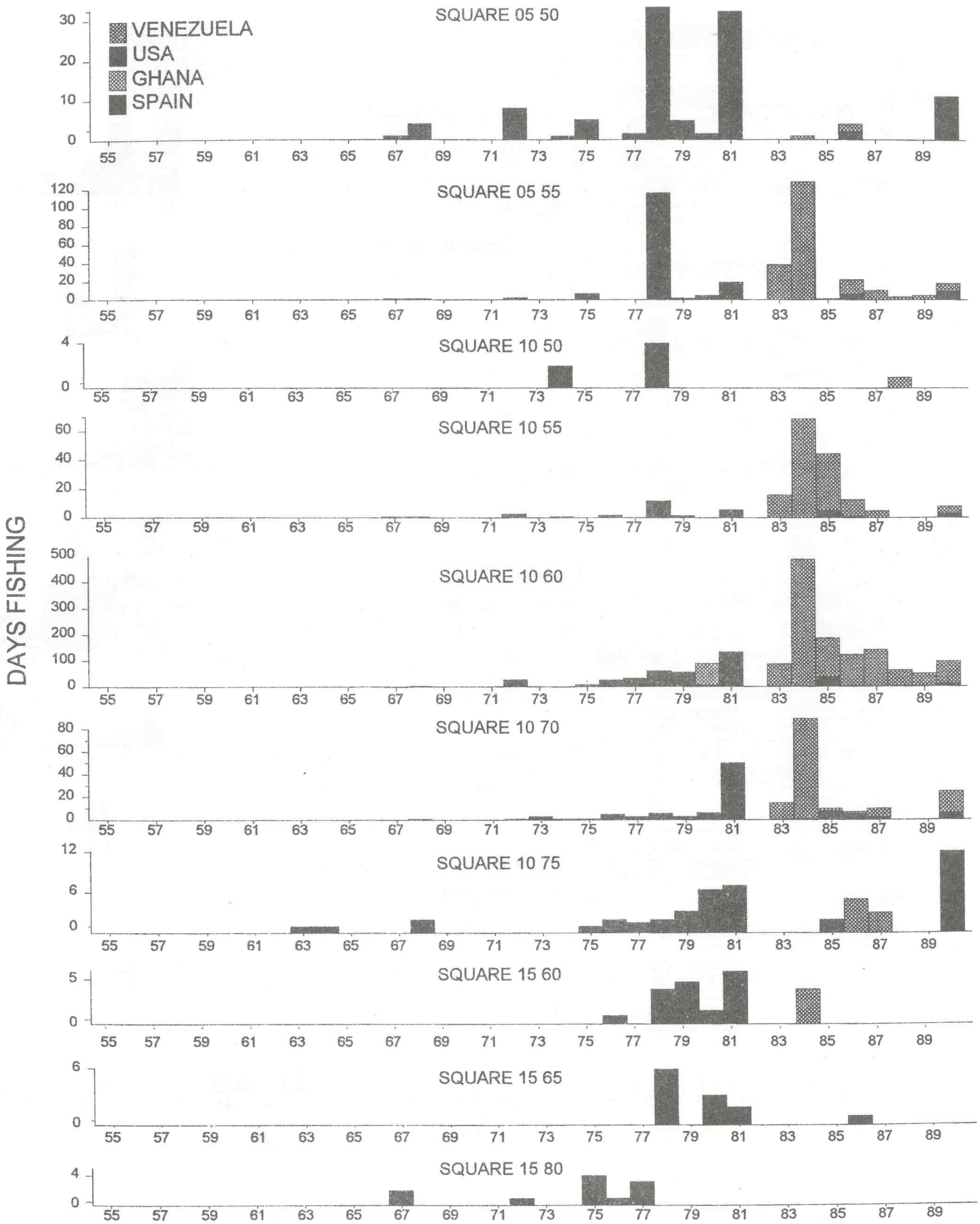

Figure 6. Purse seine fishing effort by square and country (bars are stacked in the same sequence as the key).

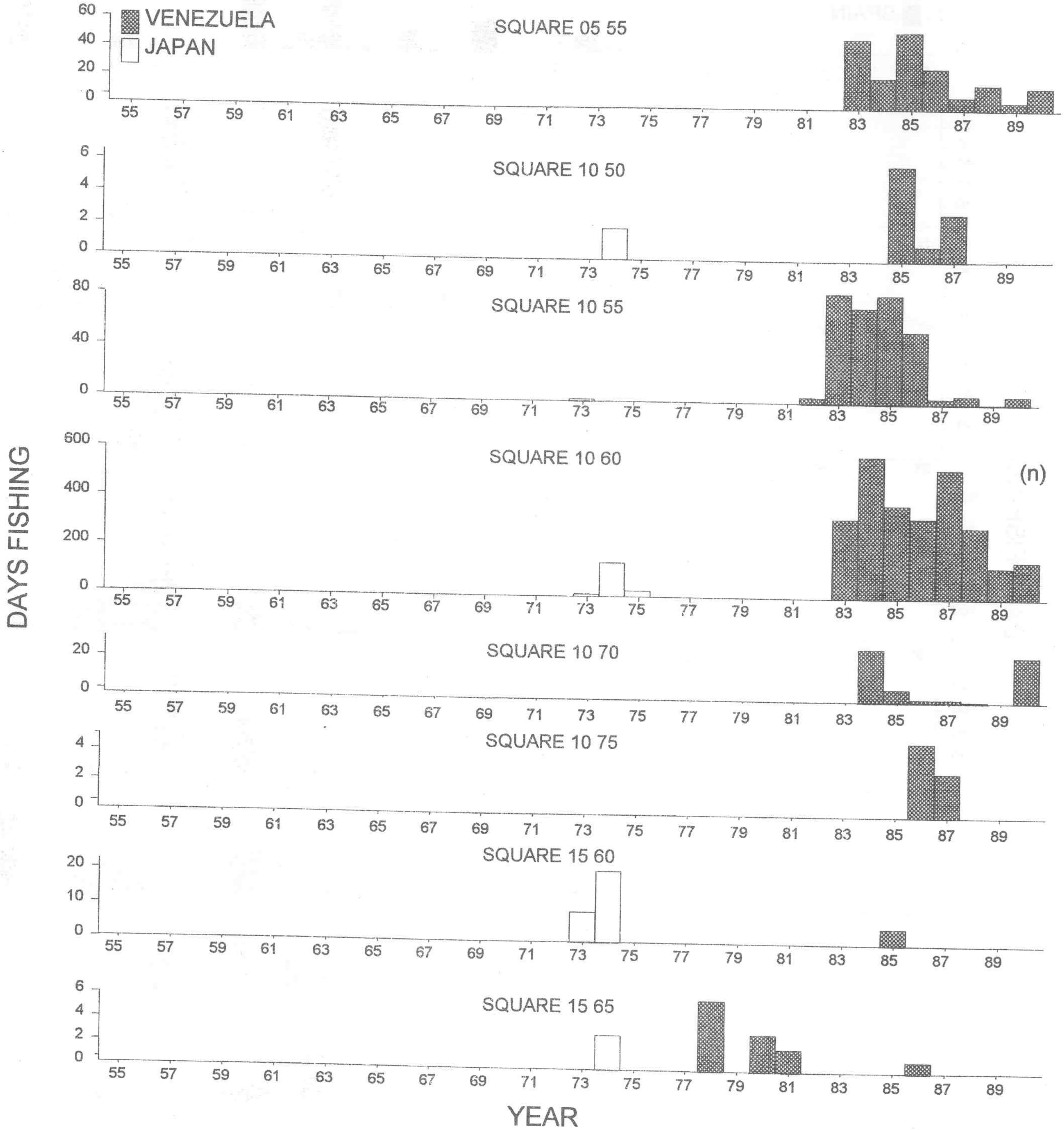

Figure 7. Baitboat effort by square and nation (bars are stacked in the same sequence as the key).

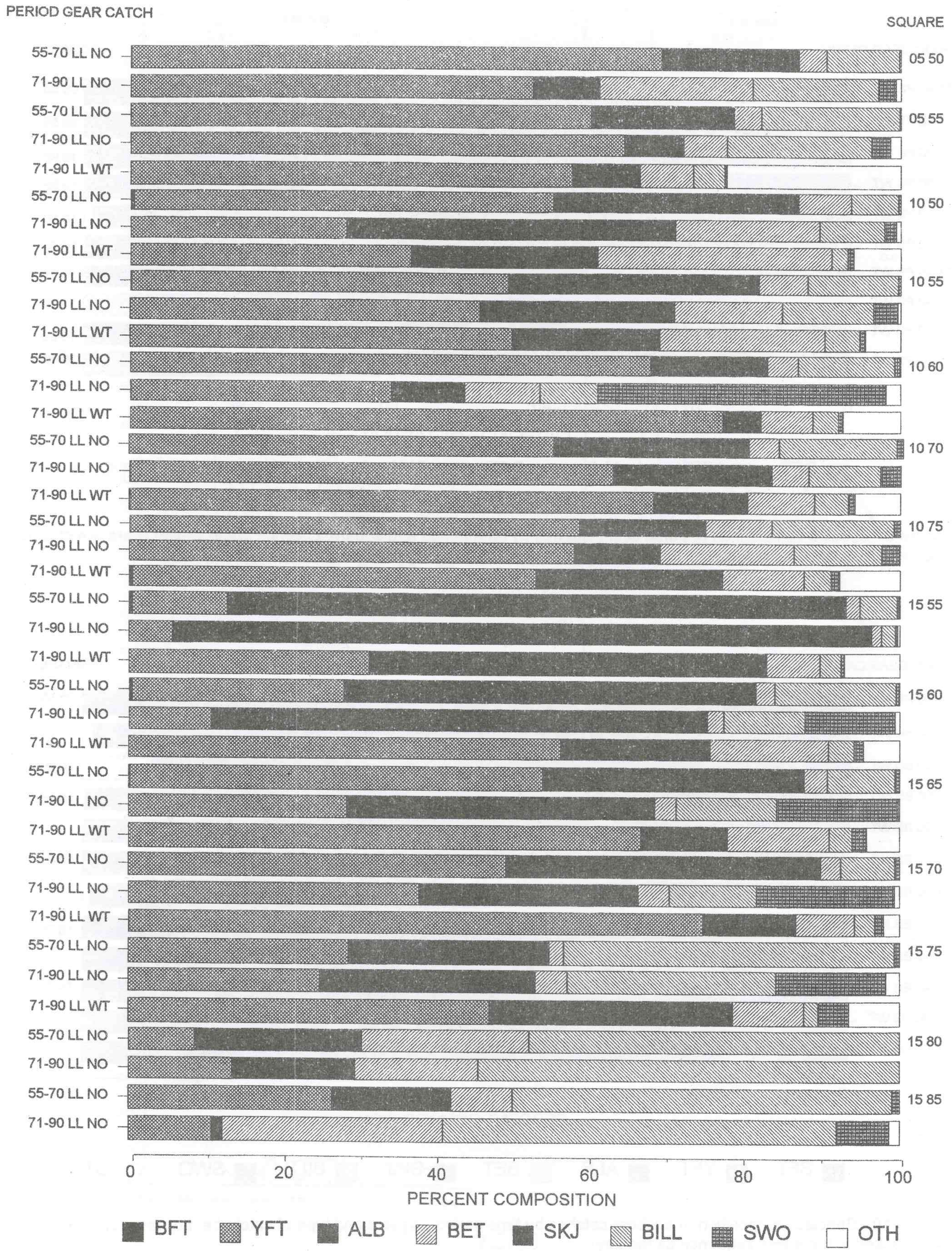

Figure 8. Species composition of longline catches by time period, square and type of catch, i.e. numbers or weight (bars are stacked in the same sequence as the key).

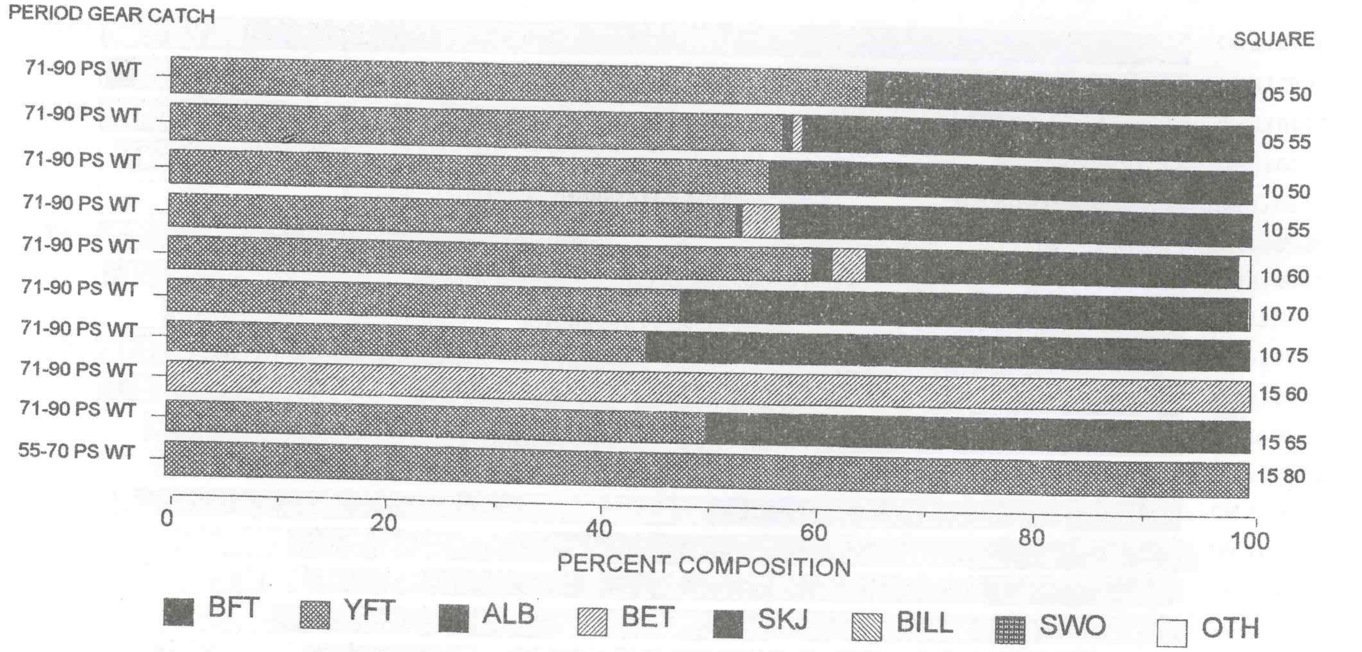

Figure 9. Species composition of purse seine catches by time period and square. Catches are in weight (bars are stacked in the same sequence as the key).

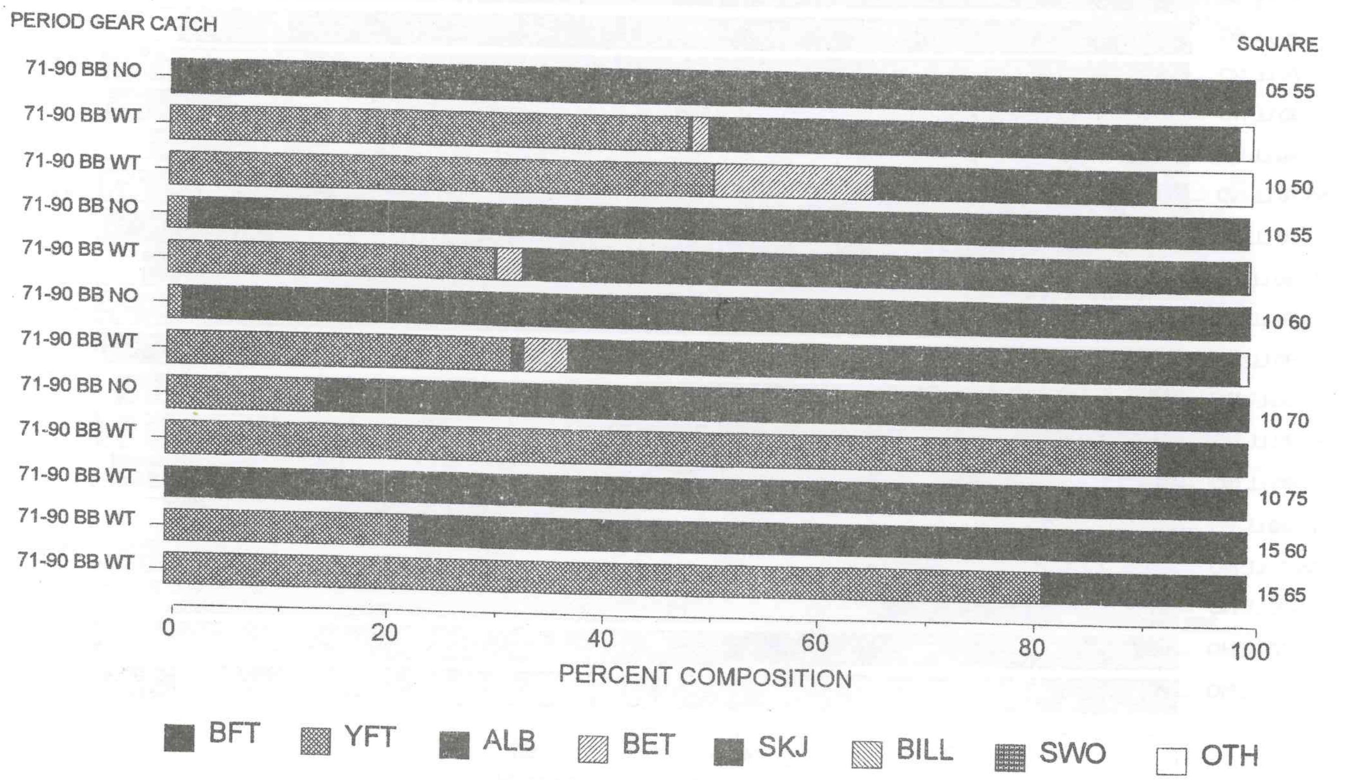

Figure 10. Species composition of baitboat catches by time period, square and type of catch, i.e. numbers or weight (bars are stacked in the same sequence as the key).

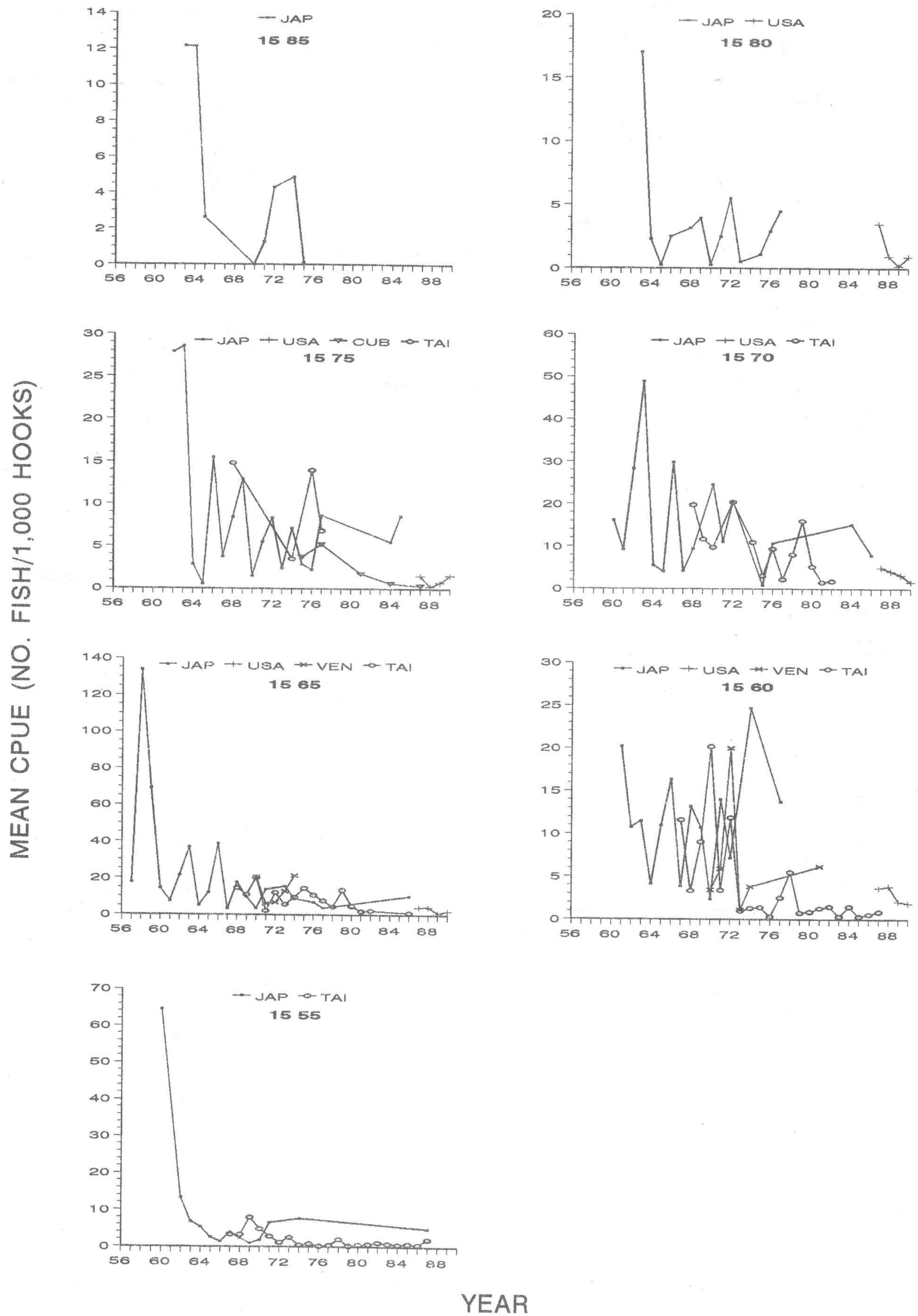

Figure 11a. Changes in yearly mean longline CPUE (no. fish/1,000 hooks) for yellowfin tuna in specified five degree squares in the north Caribbean region, during the period 1956-1990.

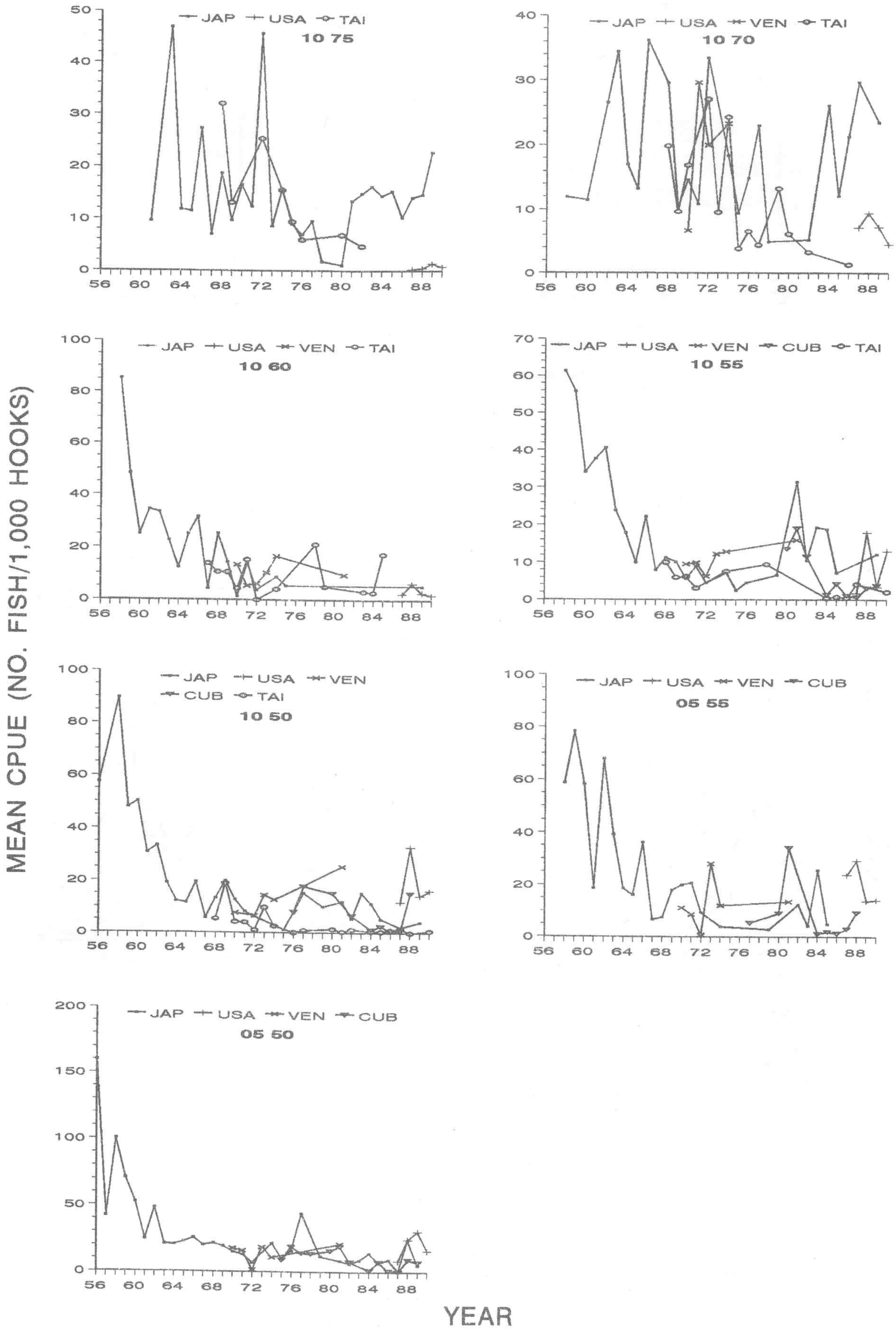

Figure 11b. Changes in yearly mean longline CPUE (no. fish/1,000 hooks) for yellowfin tuna in specified five degree squares in the south Caribbean region, during the period 1956-1990.

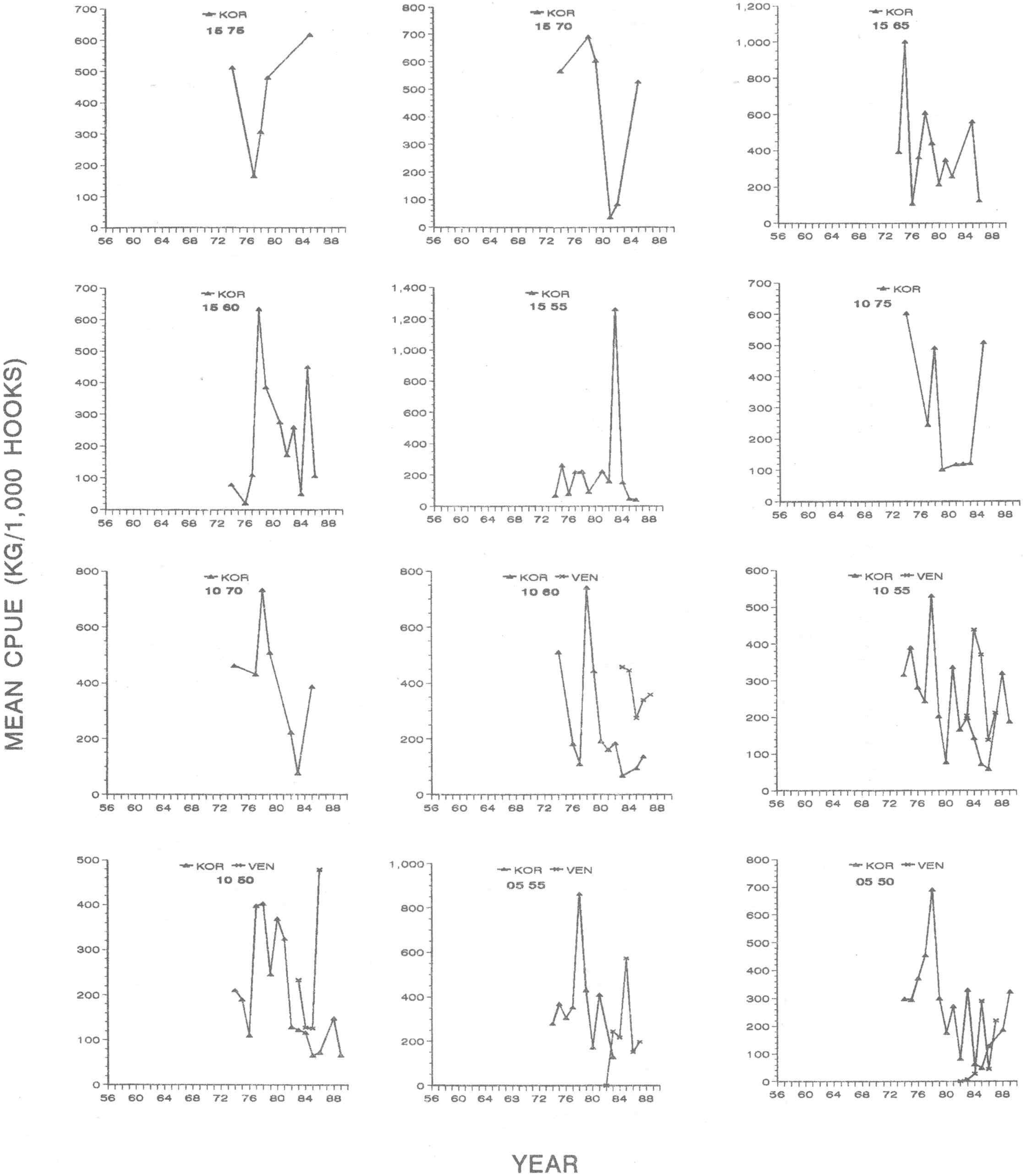

Figure 12. Changes in yearly mean longline CPUE (kg/1,000 hooks) for yellowfin tuna in specified five degree squares in the Caribbean region, during the period 1956-1990.

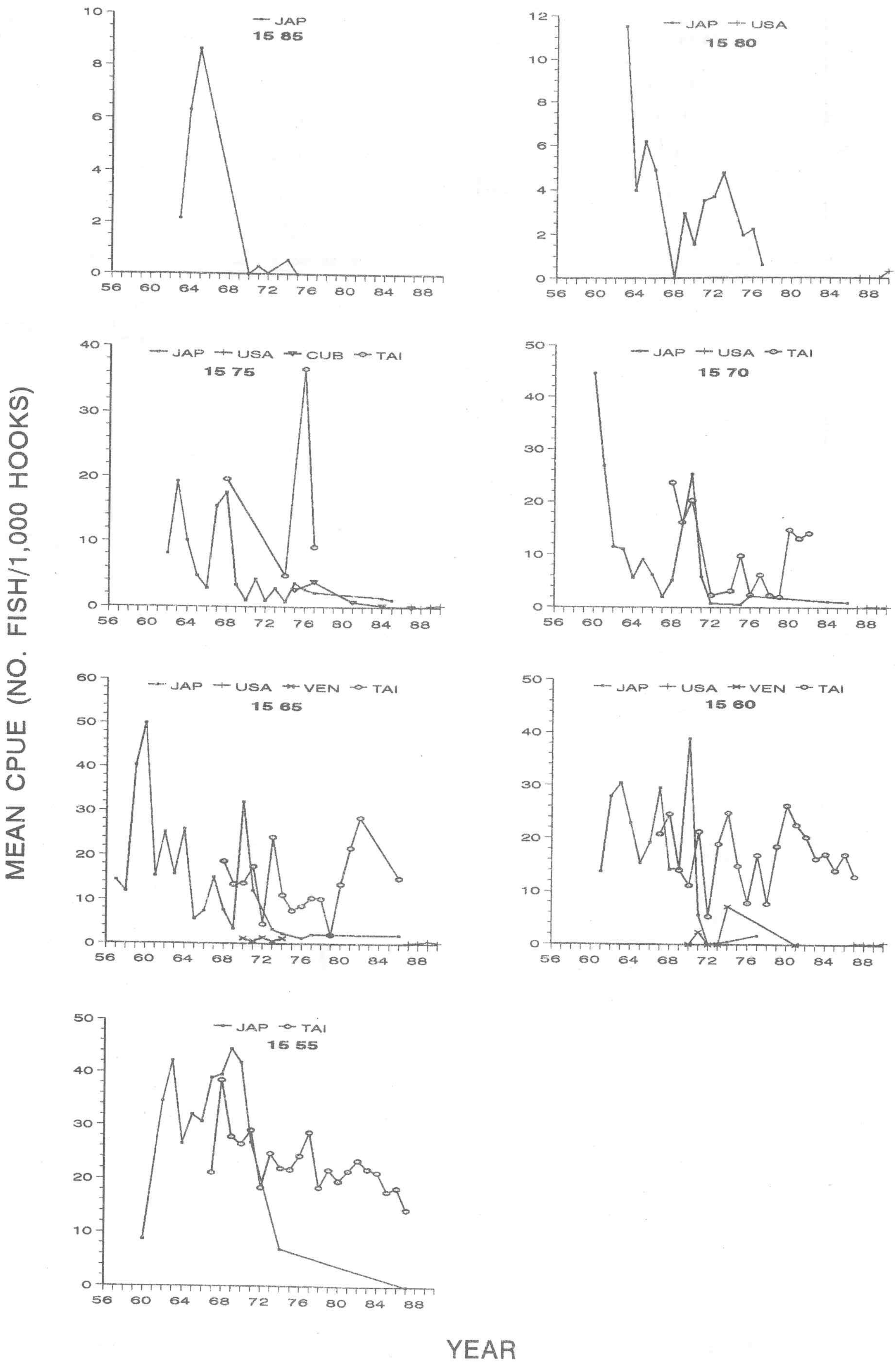

Figure 13a. Changes in yearly mean longline CPUE (no. fish/1,000 hooks) for albacore in specified five degree squares in the north Caribbean region, during the period 1956-1990.

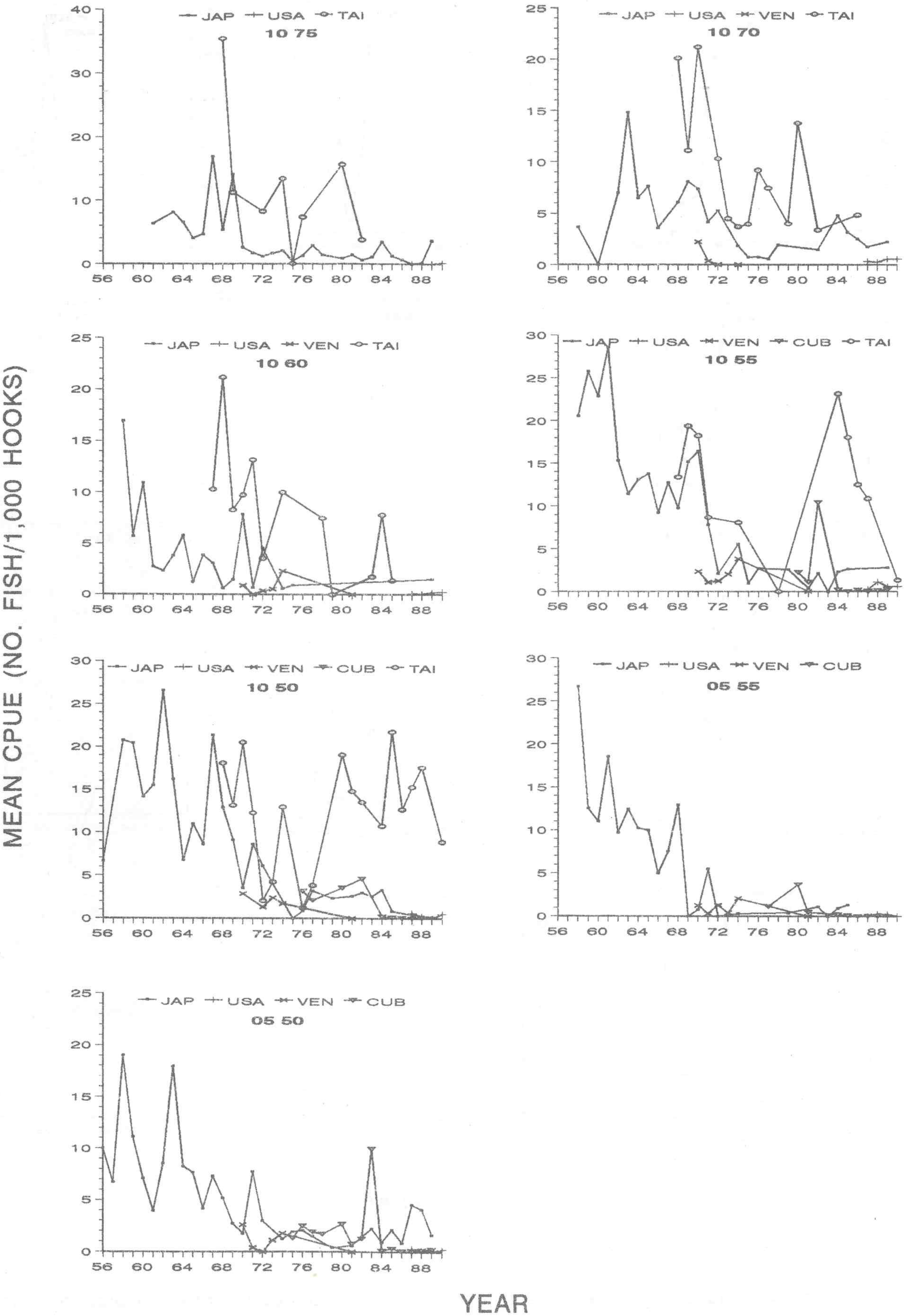

Figure 13b. Changes in yearly mean longline CPUE (no. fish/1,000 hooks) for albacore in specified five degree squares in the south Caribbean region, during the period 1956-1990.

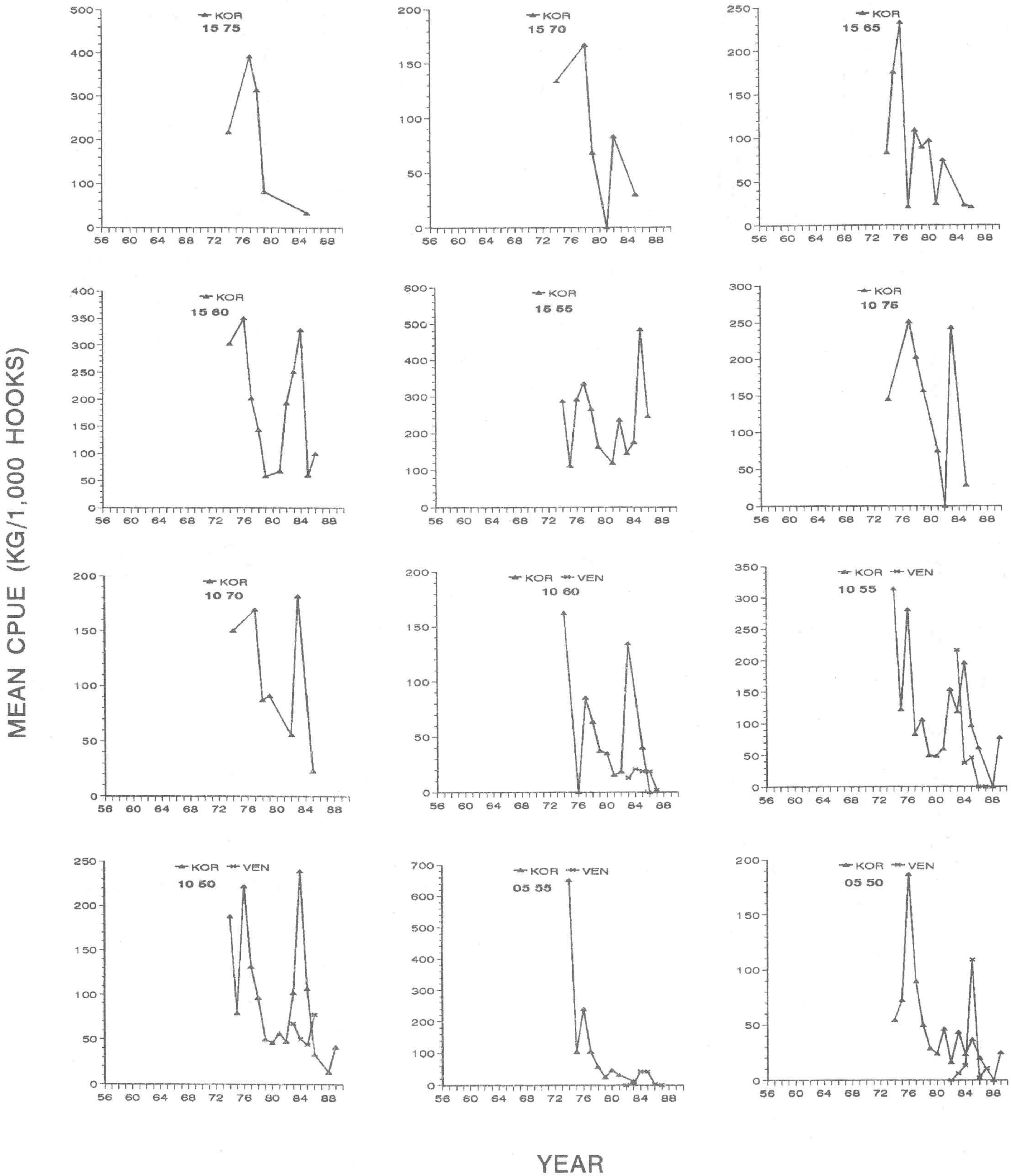

Figure 14. Changes in yearly mean longline CPUE (kg/1,000 hooks) for albacore tuna in specified five degree squares in the Caribbean region, during the period 1956-1990.

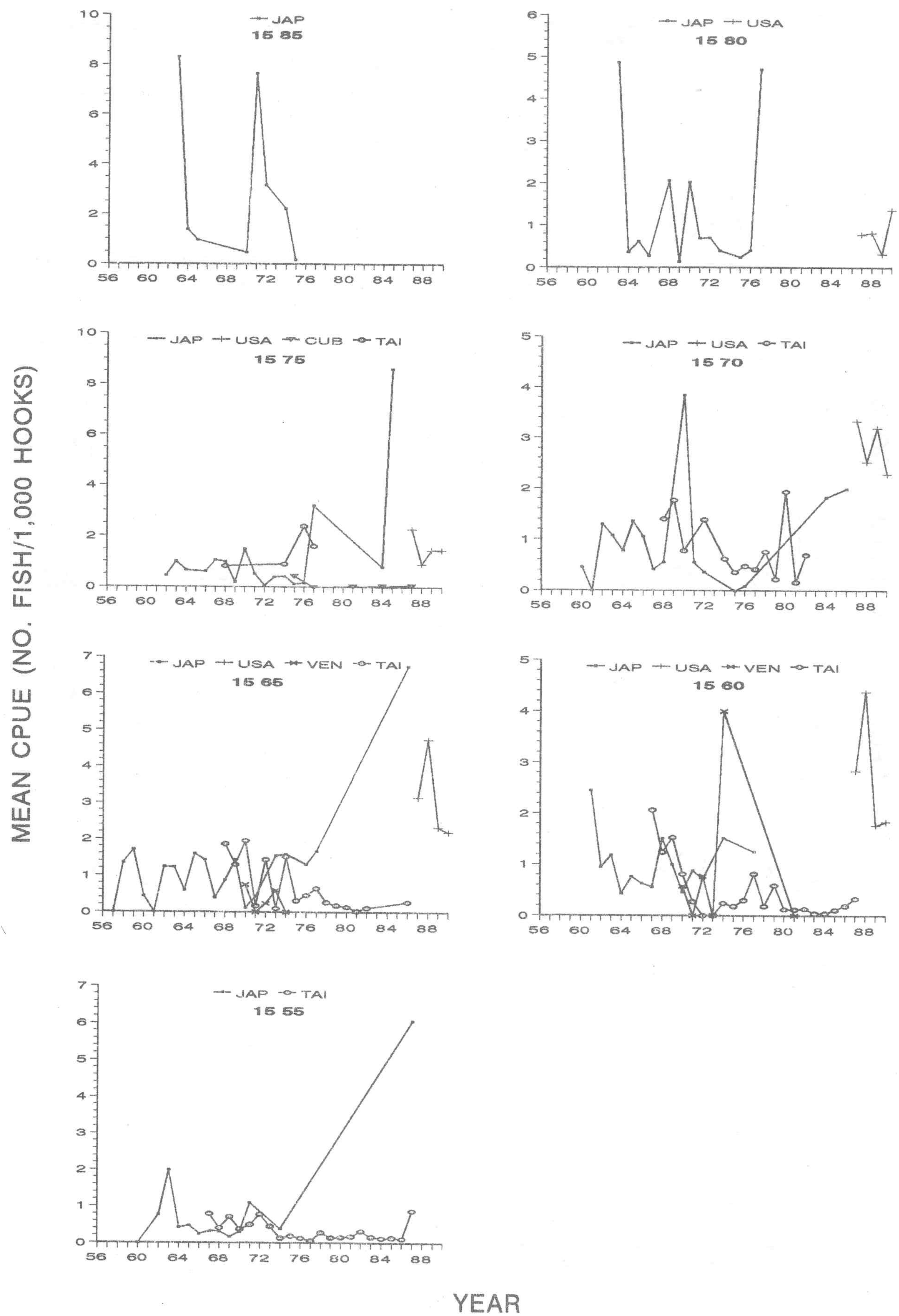

Figure 15a. Changes in yearly mean longline CPUE (no. fish/1,000 hooks) for bigeye tuna in specified five degree squares in the north Caribbean region, during the period 1956-1990.

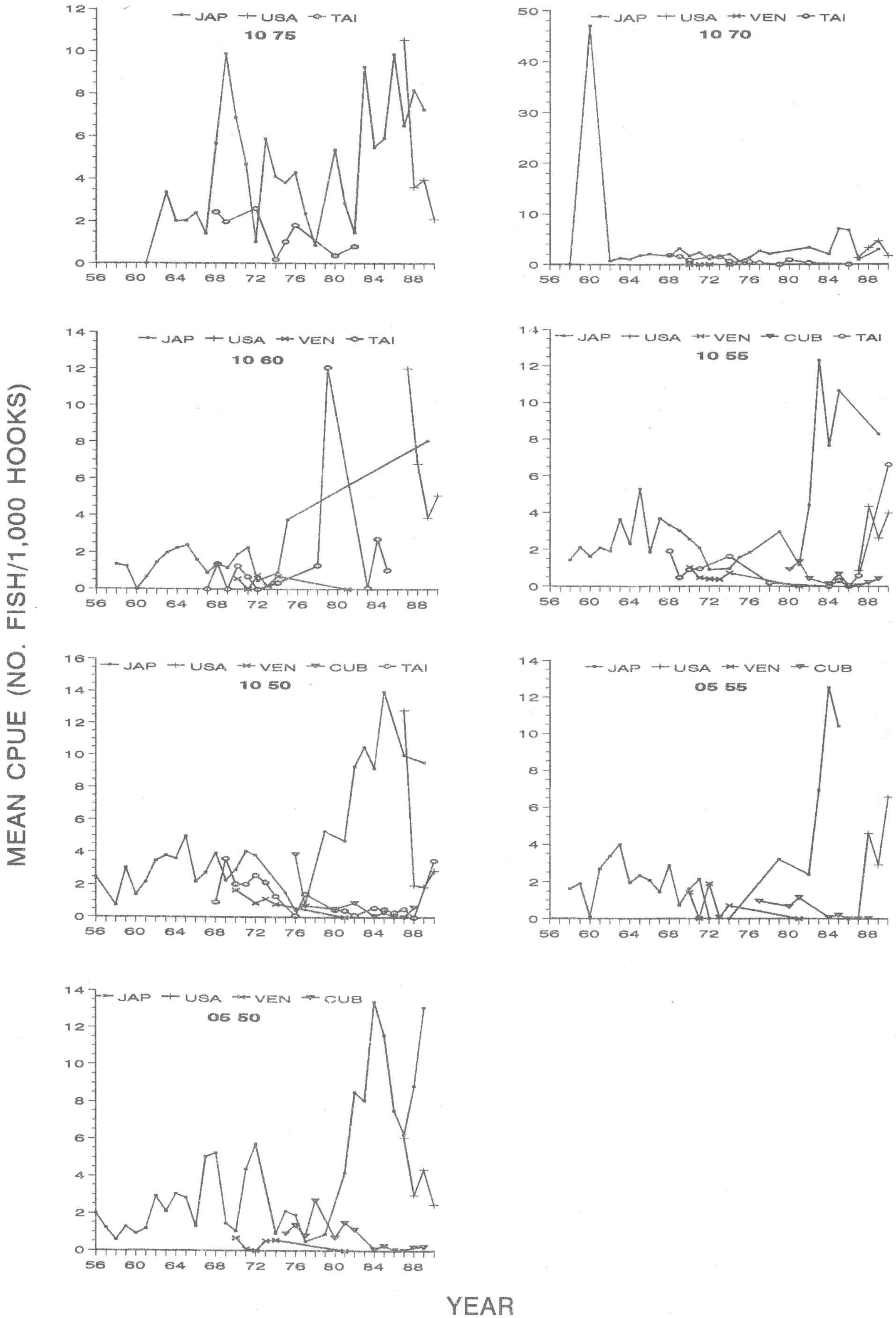

Figure 15b. Changes in yearly mean longline CPUE (no. fish/1,000 hooks) for bigeye tuna i specified five degree squares in the south Caribbean region, during the period 1956-1990.

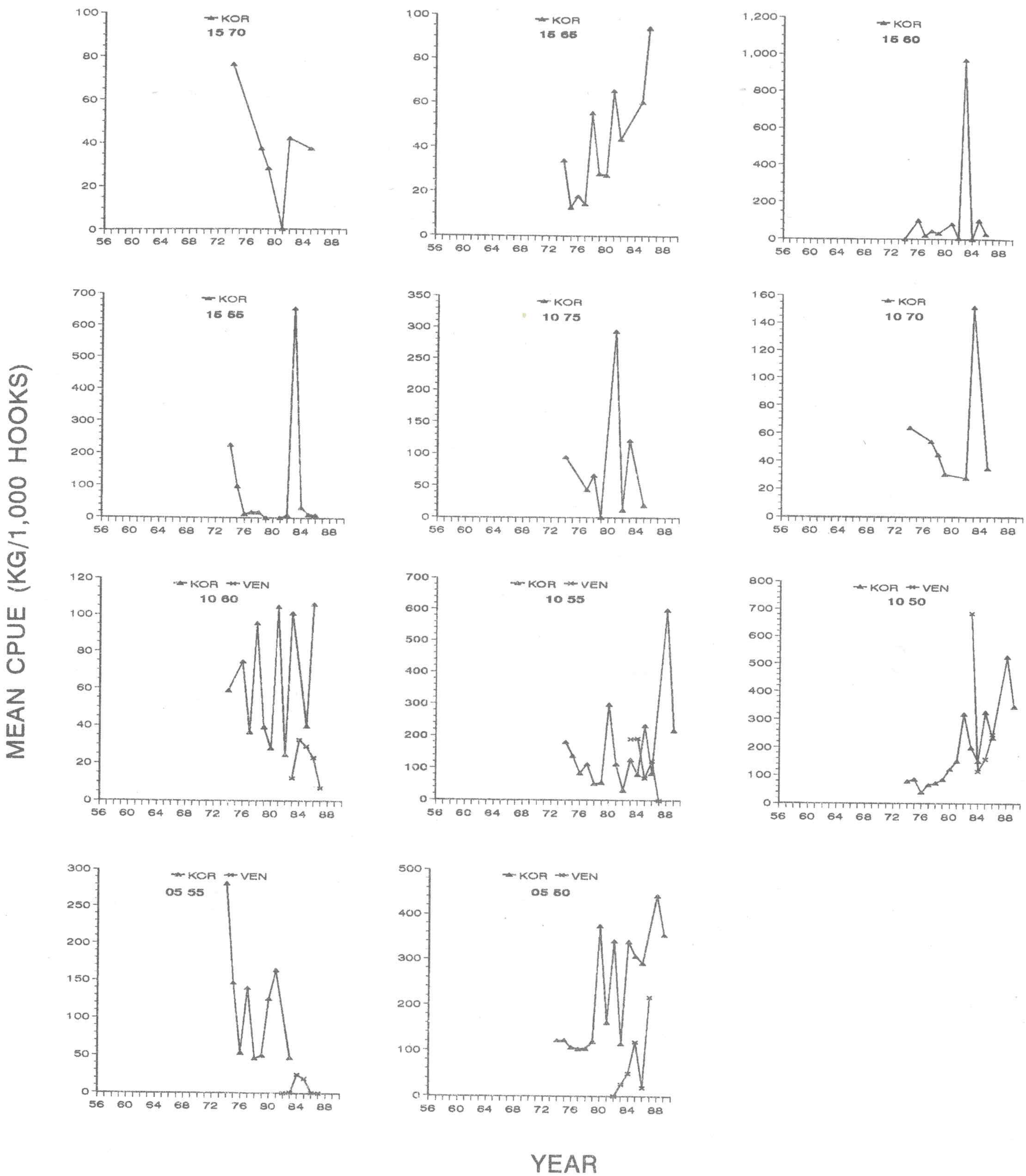

Figure 16. Changes in yearly mean longline CPUE (kg/1,000 hooks) for bigeye tuna in specified five degree squares in the Caribbean region, during the period 1956-1990.

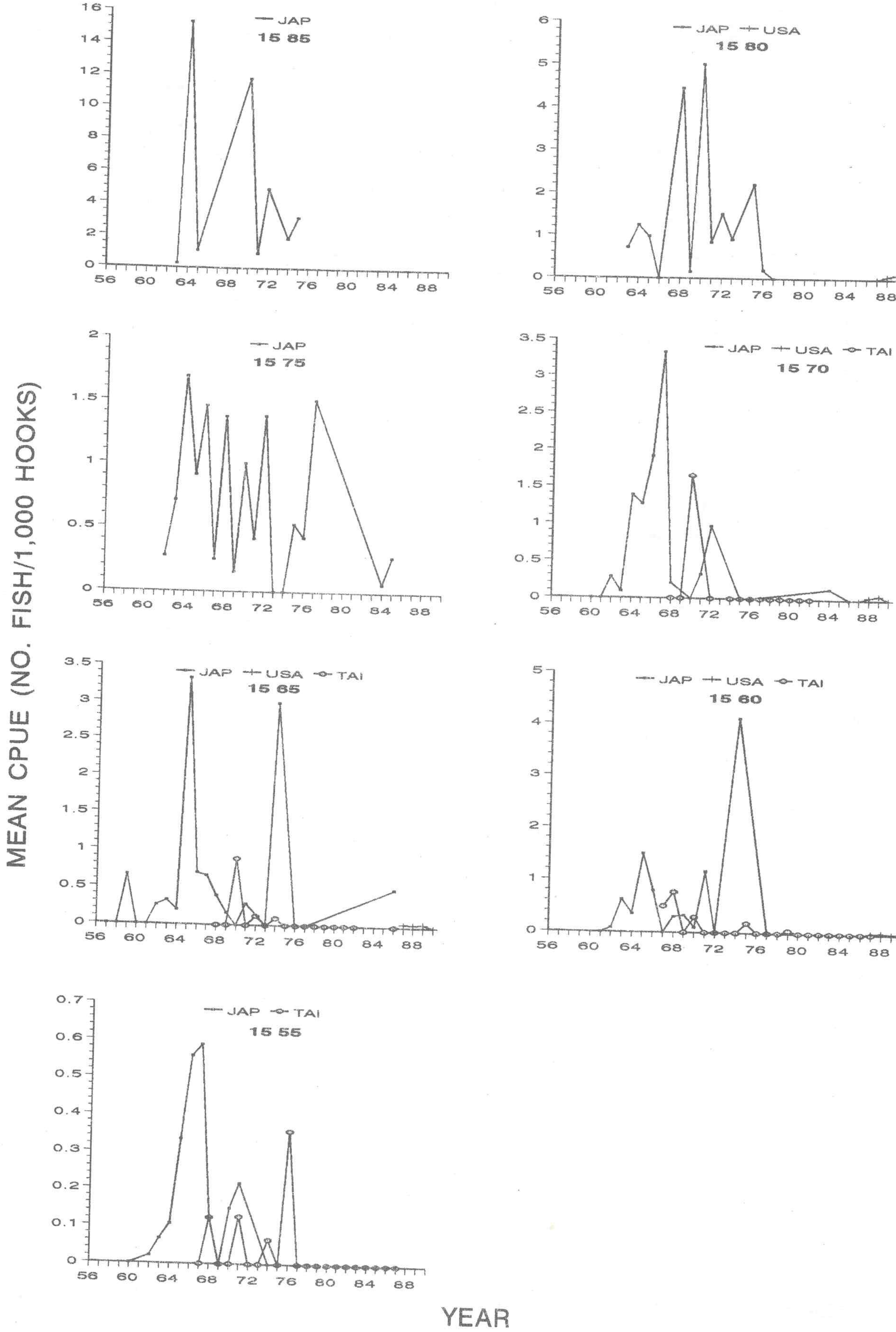

Figure 17a. Changes in yearly mean longline CPUE (no. fish/1,000 hooks) for sailfish specified five degree squares in the north Caribbean region, during the period 1956-1

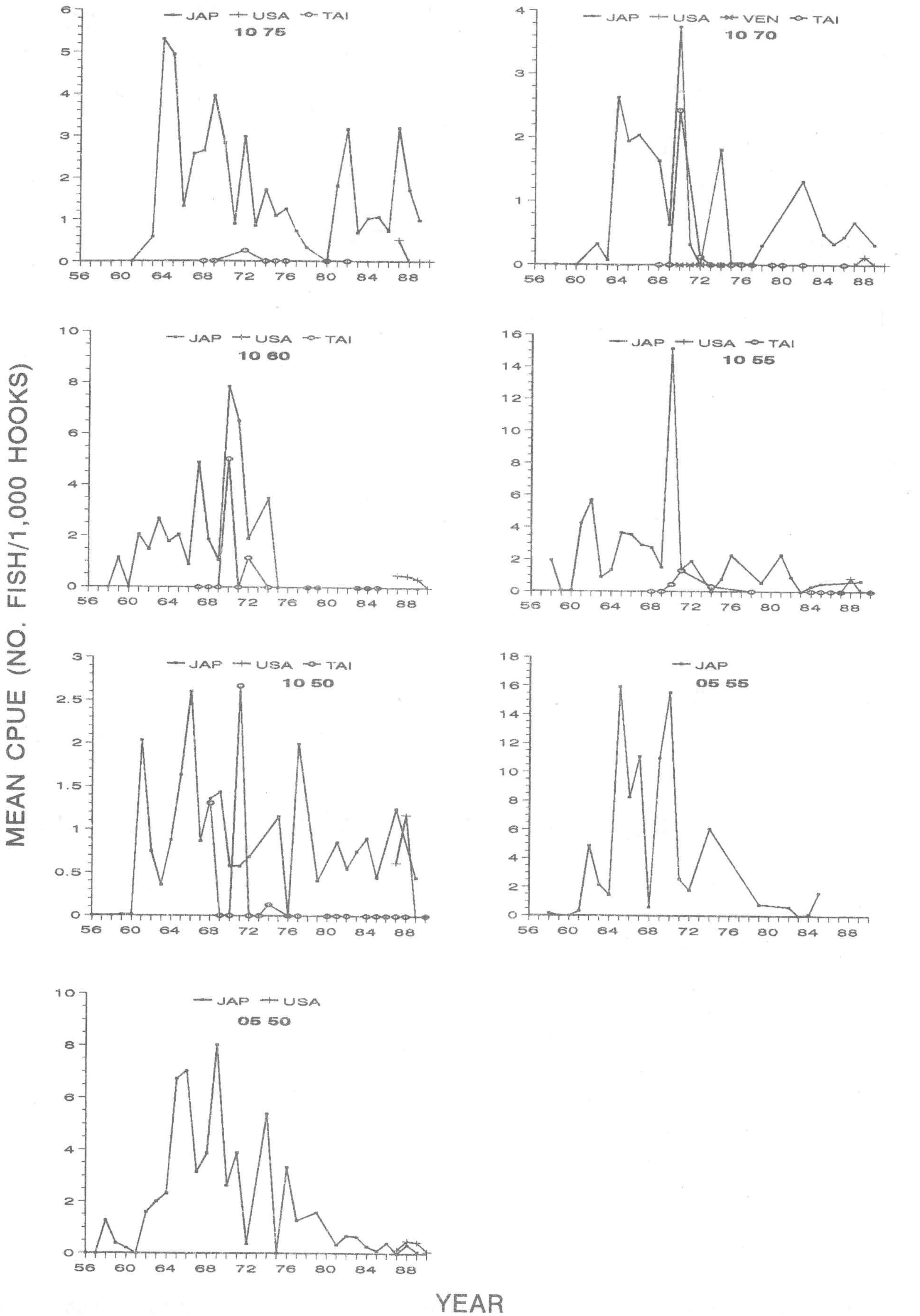

Figure 17b. Changes in yearly mean longline CPUE (no. fish/1,000 hooks) for sailfish in specified five degree squares in the south Caribbean region, during the period 1956-1990.

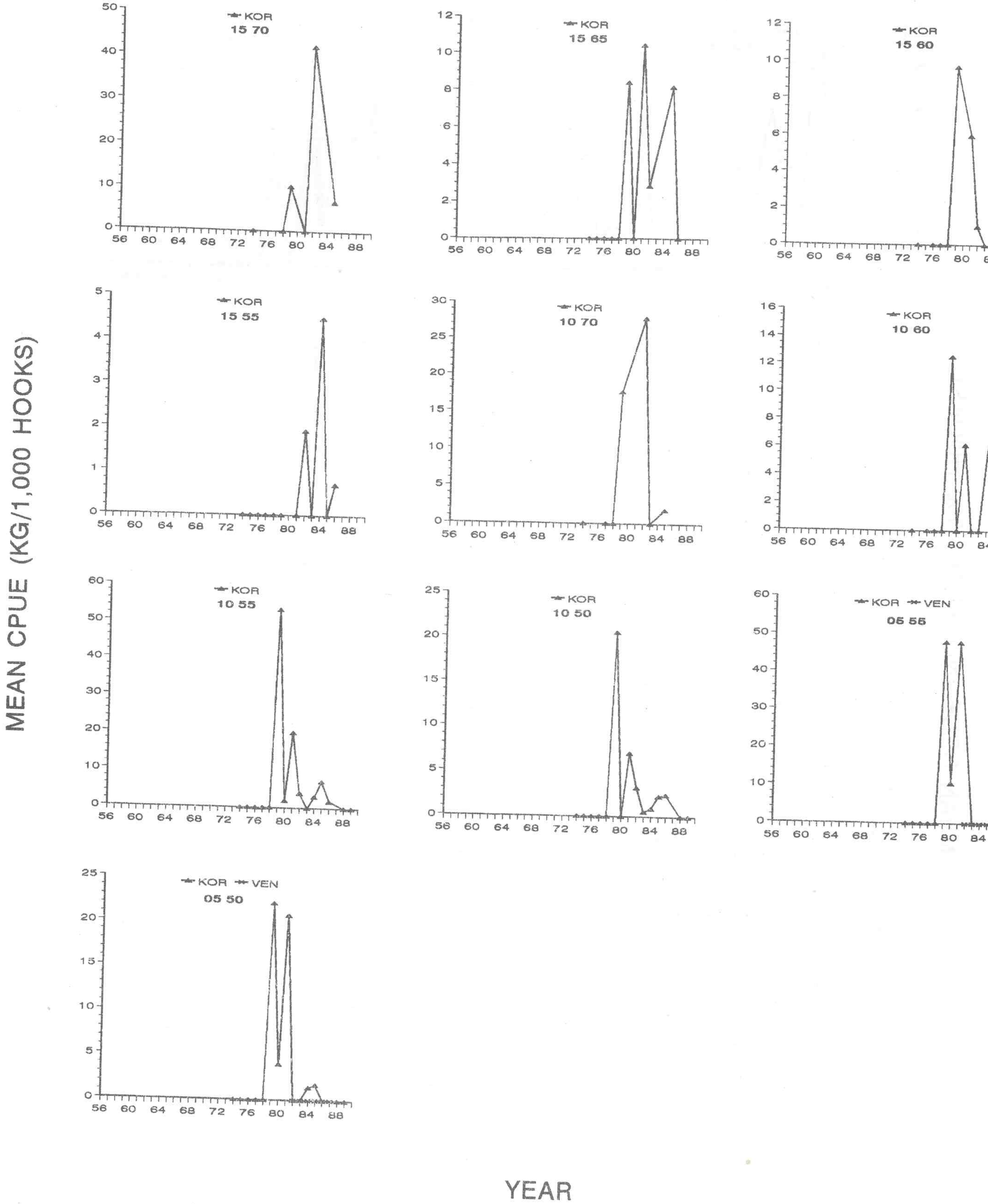

Figure 18. Changes in yearly mean longline CPUE (kg/1,000 hooks) for sailfish in specified five degree squares in the Caribbean region, during the period 1956-1990.

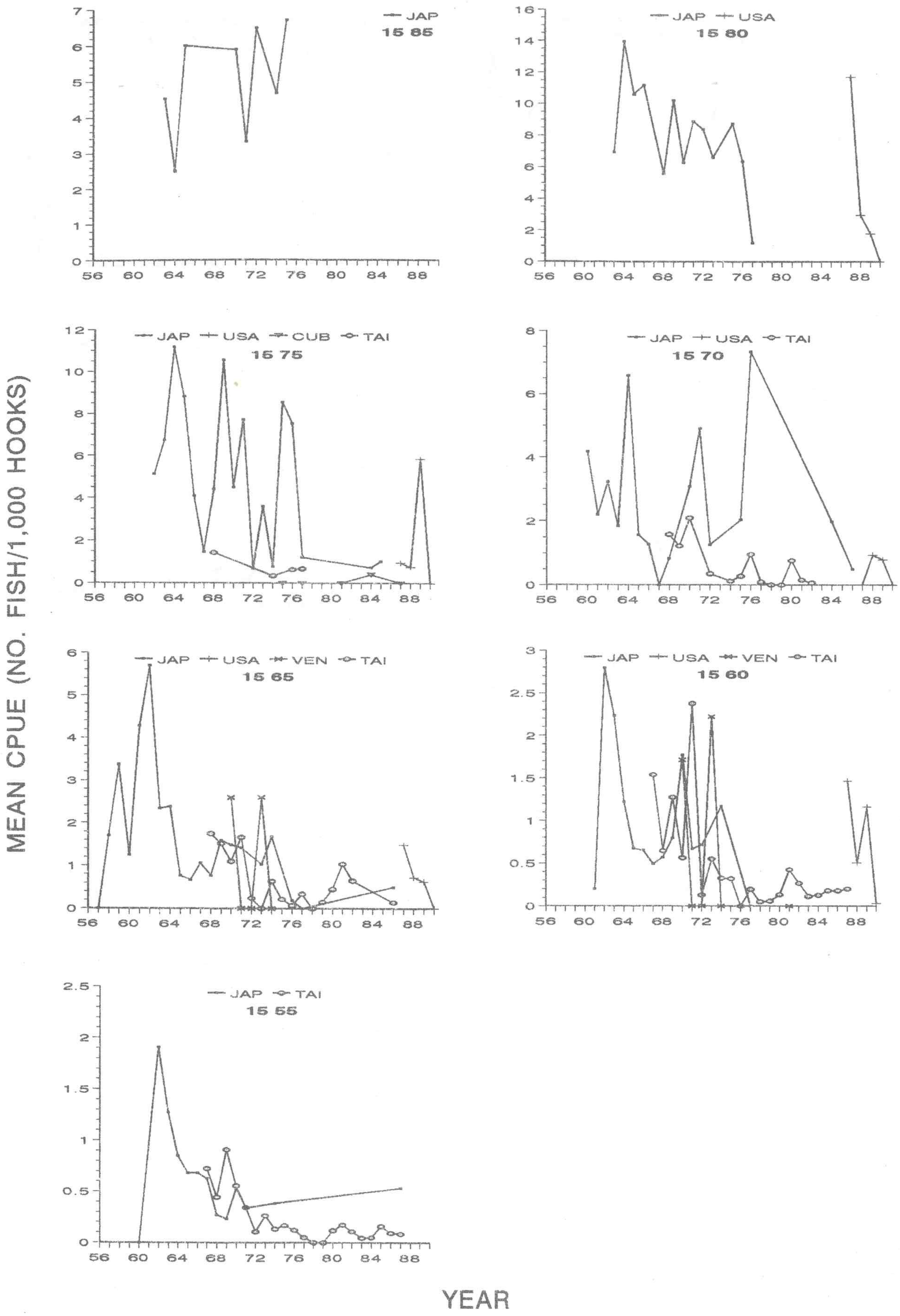

Figure 19a. Changes in yearly mean longline CPUE (no. fish/1,000 hooks) for blue marlin in specified five degree squares in the north Caribbean region, during the period 1956-1990.

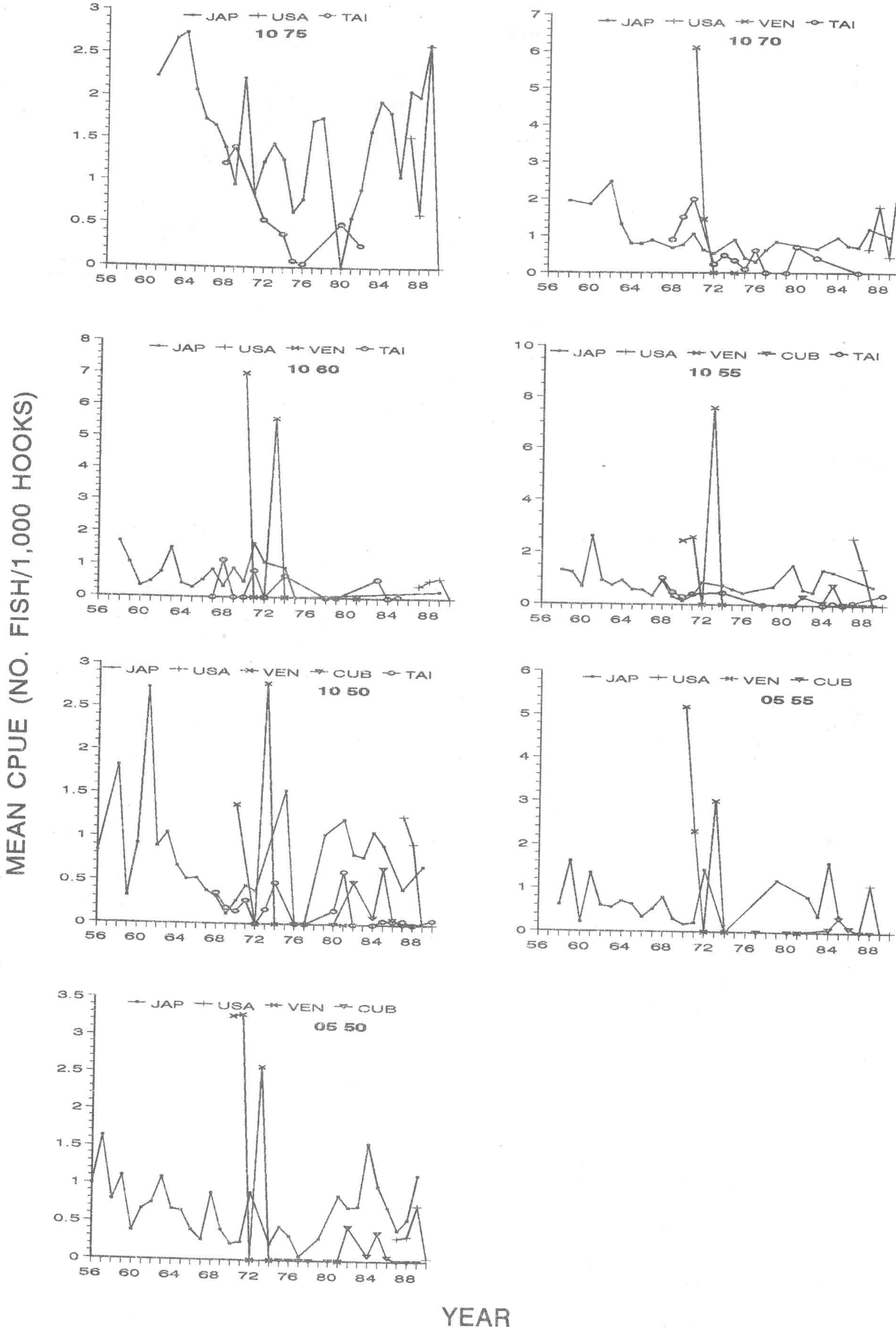

Figure 19b. Changes in yearly mean longline CPUE (no. fish/1,000 hooks) for blue marl
specified five degree squares in the south Caribbean region, during the period 1956-199

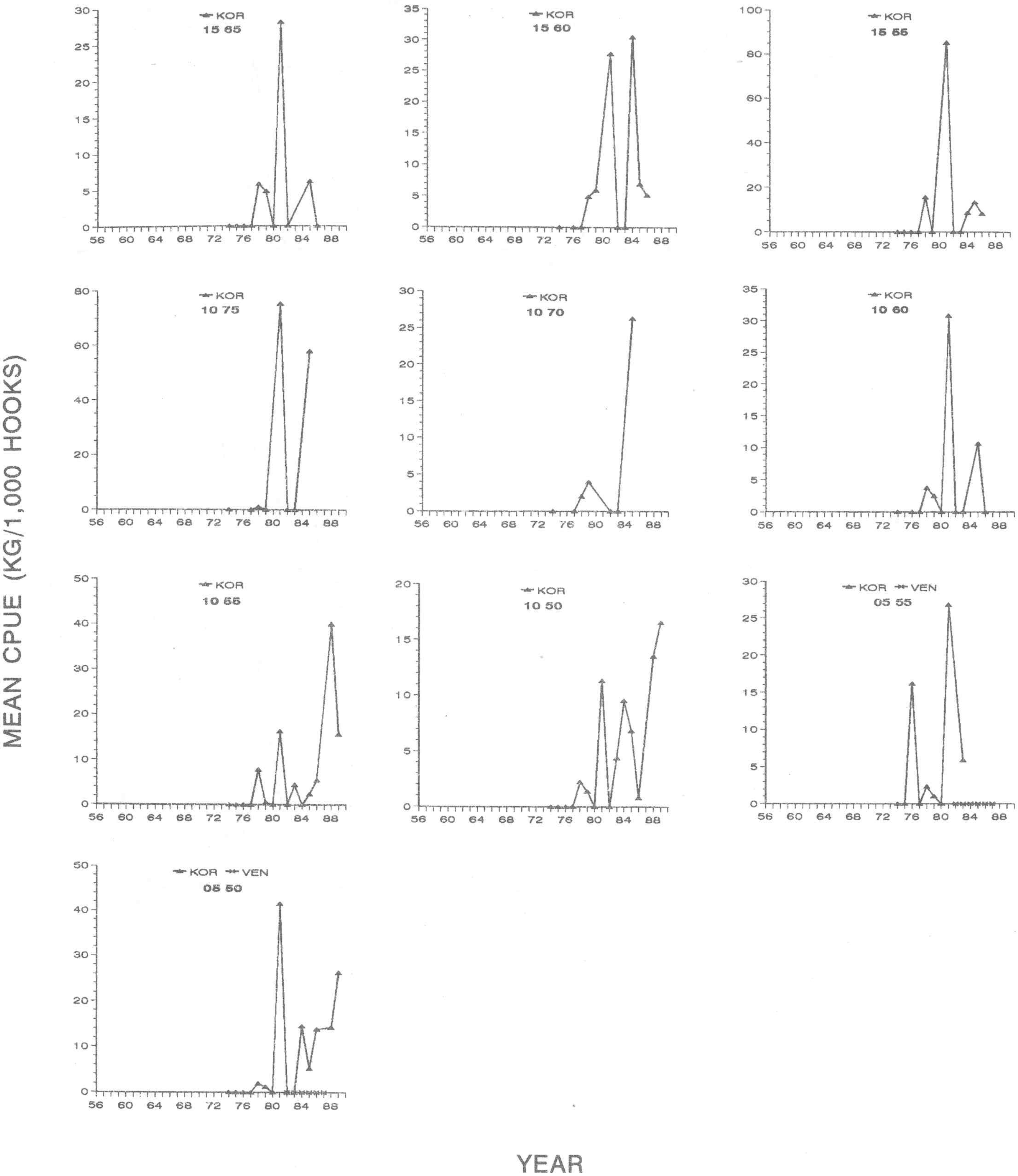

Figure 20. Changes in yearly mean longline CPUE (kg/1,000 hooks) for blue marlin in specified five degree squares in the Caribbean region, during the period 1956-1990.

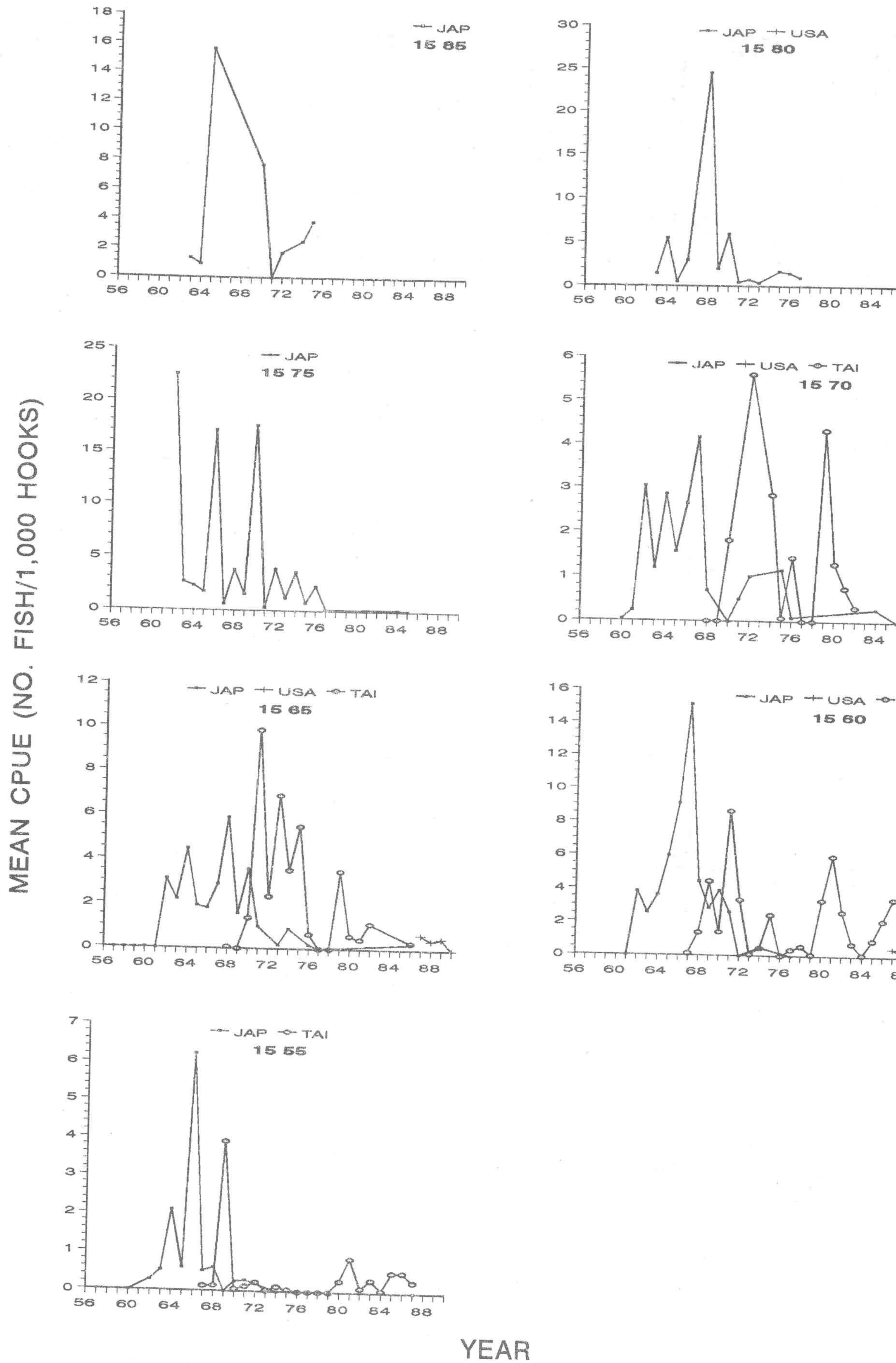

Figure 21a. Changes in yearly mean longline CPUE (no. fish/1,000 hooks) for white r
specified five degree squares in the north Caribbean region, during the period 1956-1

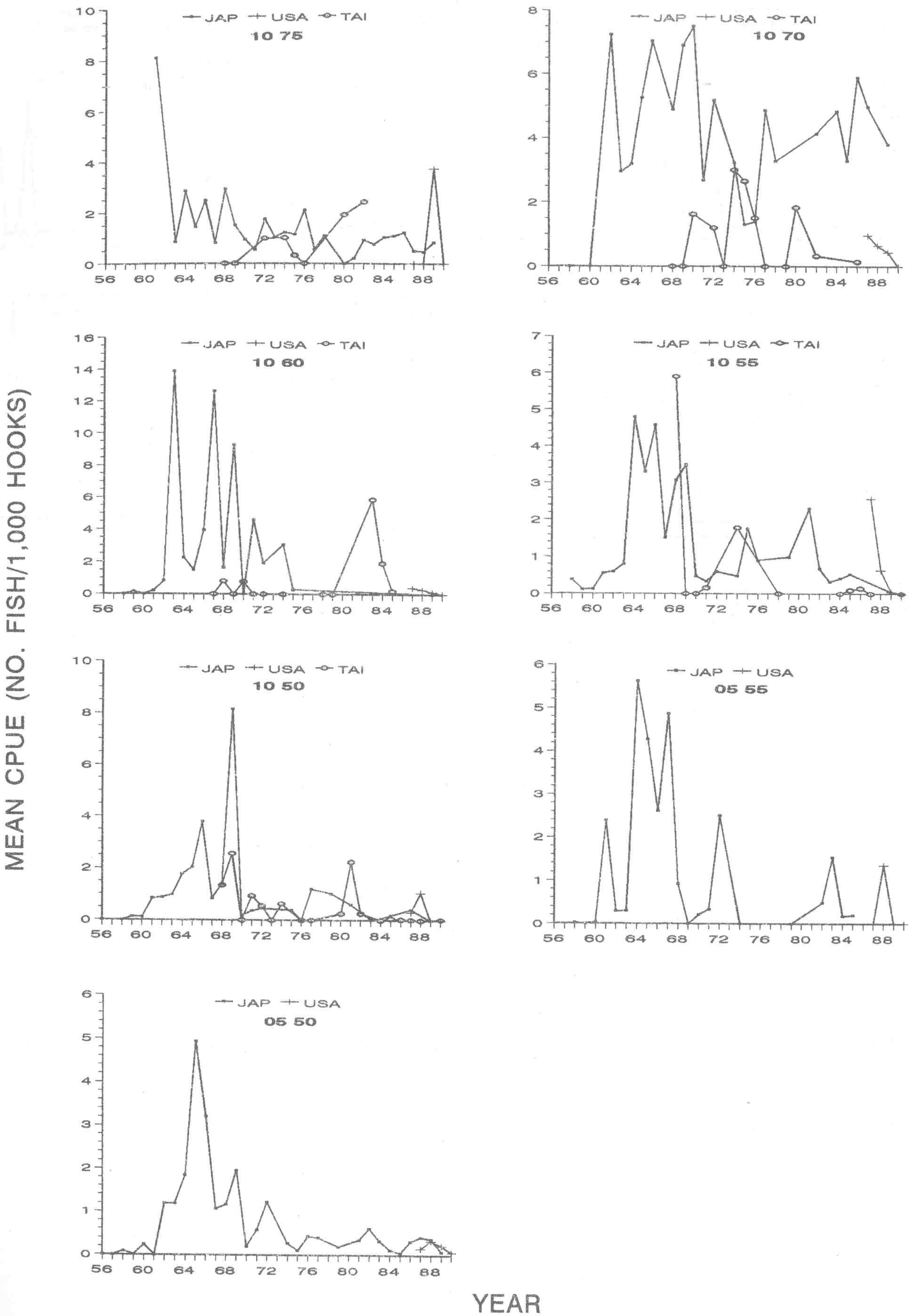

Figure 21b. Changes in yearly mean longline CPUE (no. fish/1,000 hooks) for white marlin in specified five degree squares in the south Caribbean region, during the period 1956-1990.

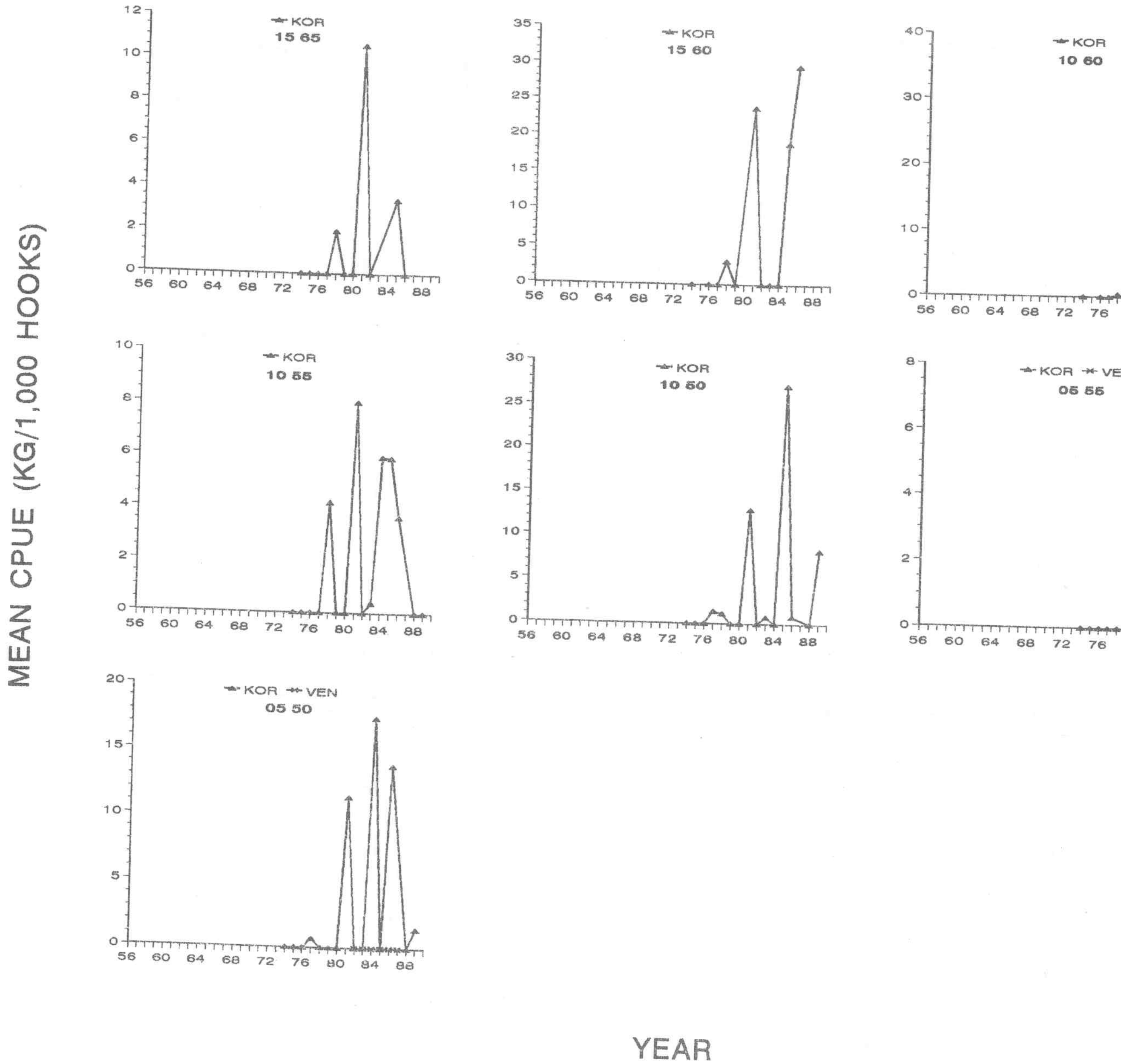

Figure 22. Changes in yearly mean longline CPUE (kg/1,000 hooks) for white marlin specified five degree squares in the Caribbean region, during the period 1956-1990.

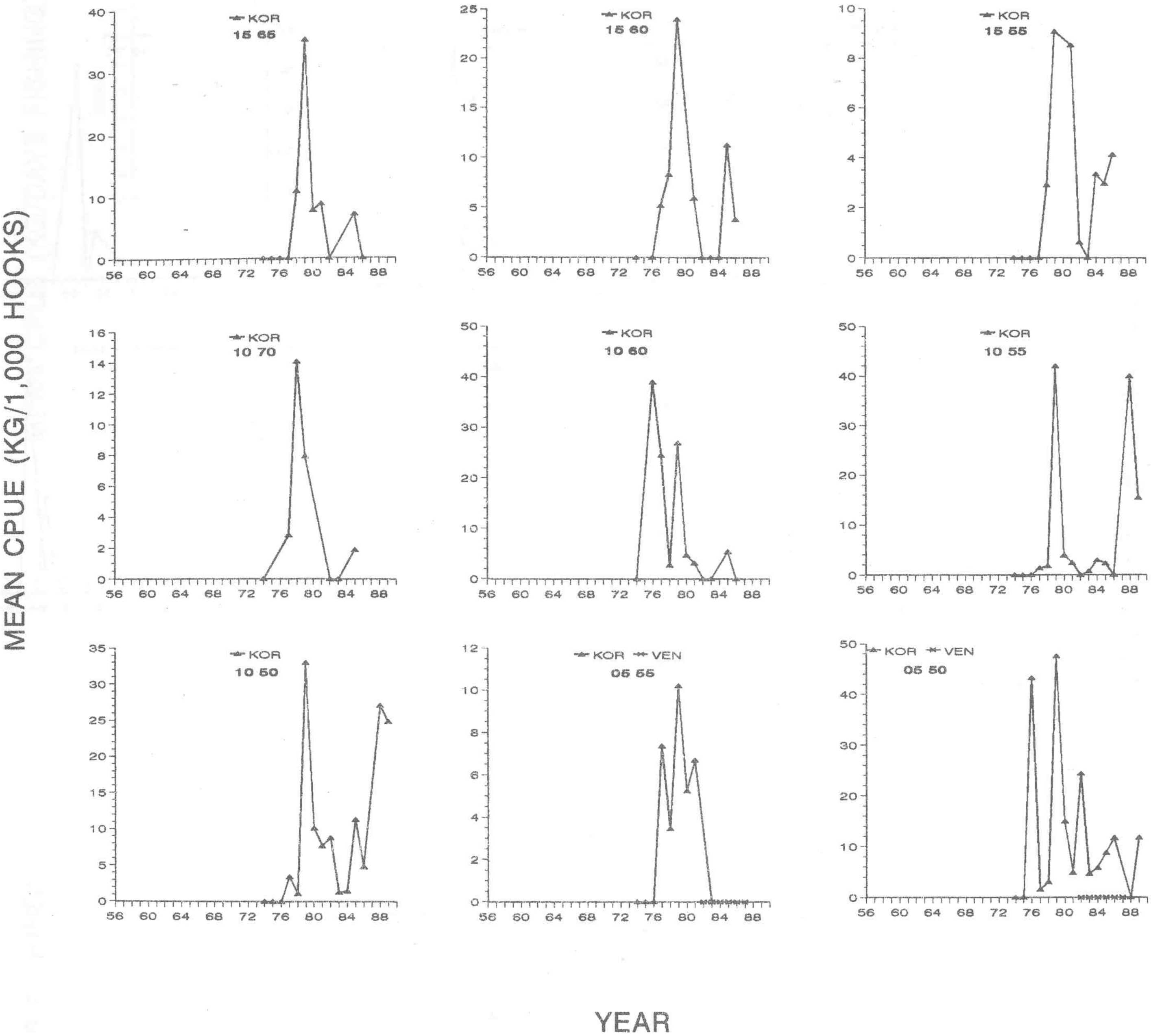

Figure 23. Changes in yearly mean longline CPUE (kg/1,000 hooks) for swordfish in specified five degree squares in the Caribbean region, during the period 1956-1990.

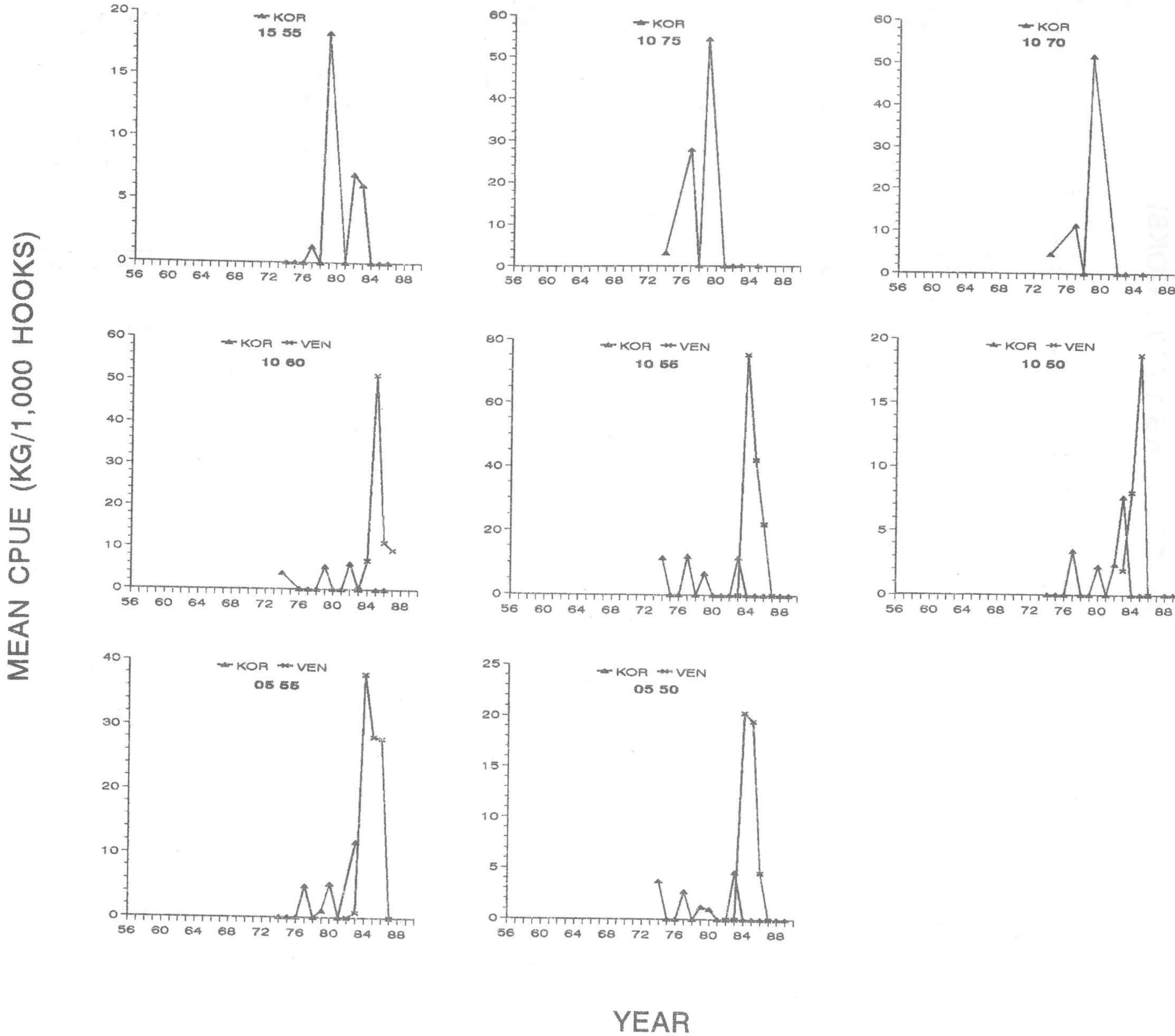

Figure 24. Changes in yearly mean longline CPUE (kg/1,000 hooks) for billfishes (all species combined) in specified five degree squares in the Caribbean region, during the period 1956-1990.

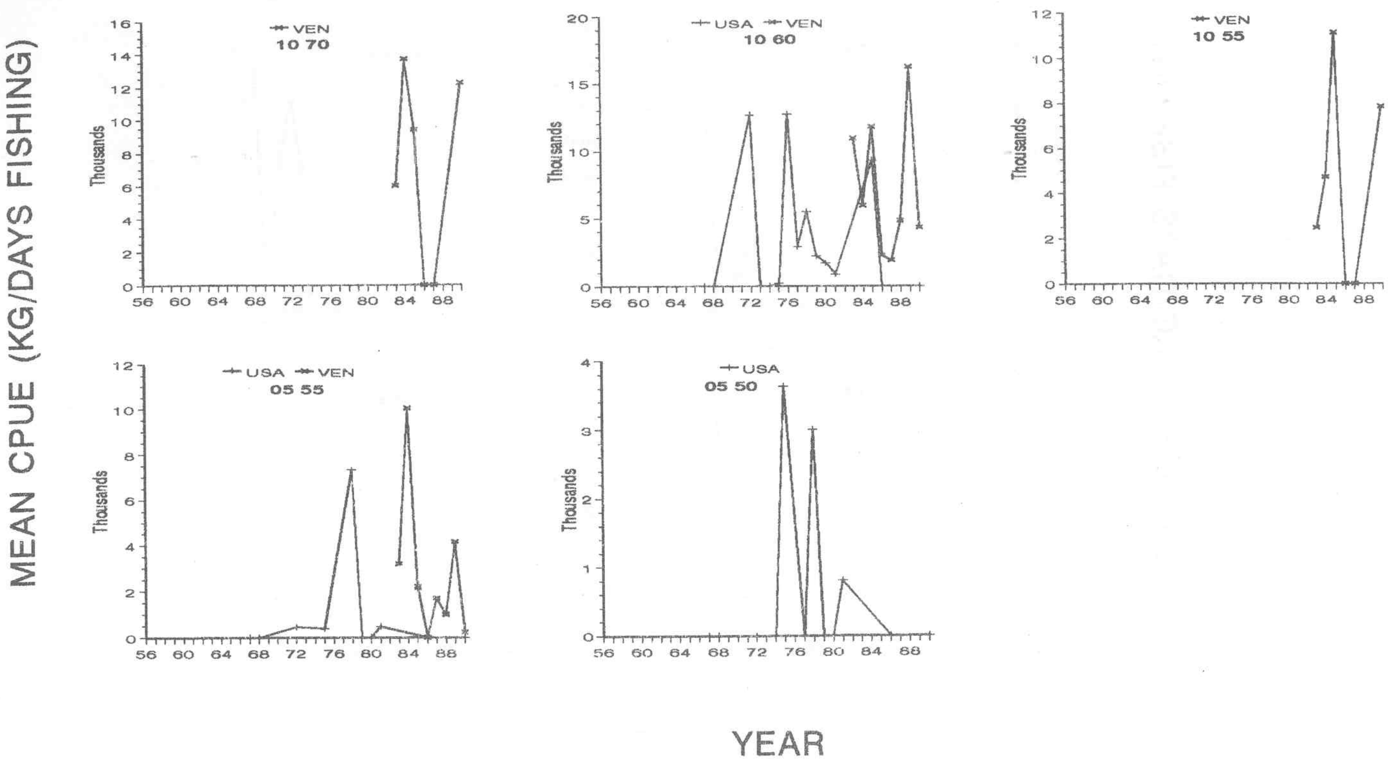

Figure 25. Changes in yearly mean purse seine CPUE (kg/days fishing) for yellowfin tuna in specified five degree squares in the Caribbean region, during the period 1956-1990.

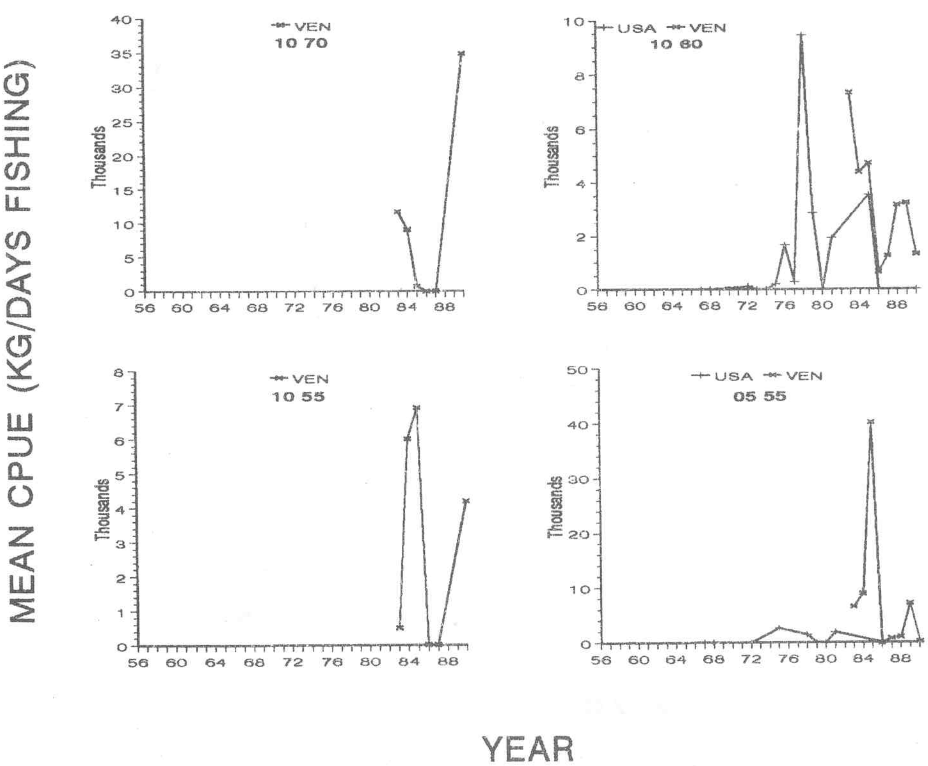

Figure 26. Changes in yearly mean purse seine CPUE (kg/days fishing) for skipjack tuna in specified five degree squares in the Caribbean region, during the period 1956-1990.

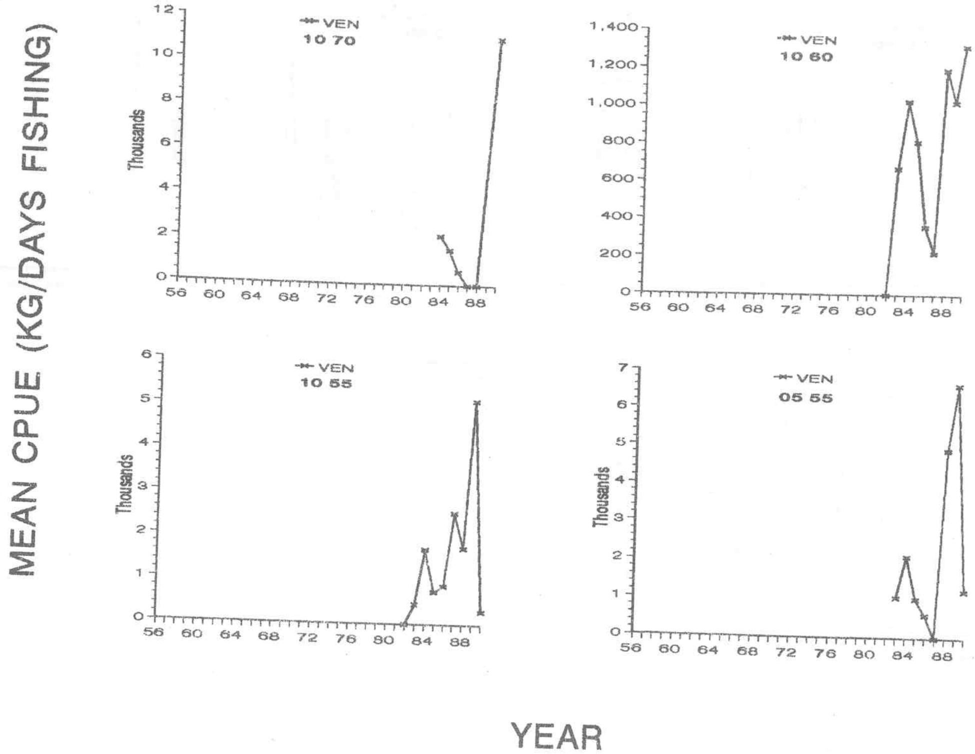

Figure 27. Changes in yearly mean baitboat CPUE (kg/days fishing) for yellowfin tuna in specified five degree squares in the Caribbean region, during the period 1956-1990.

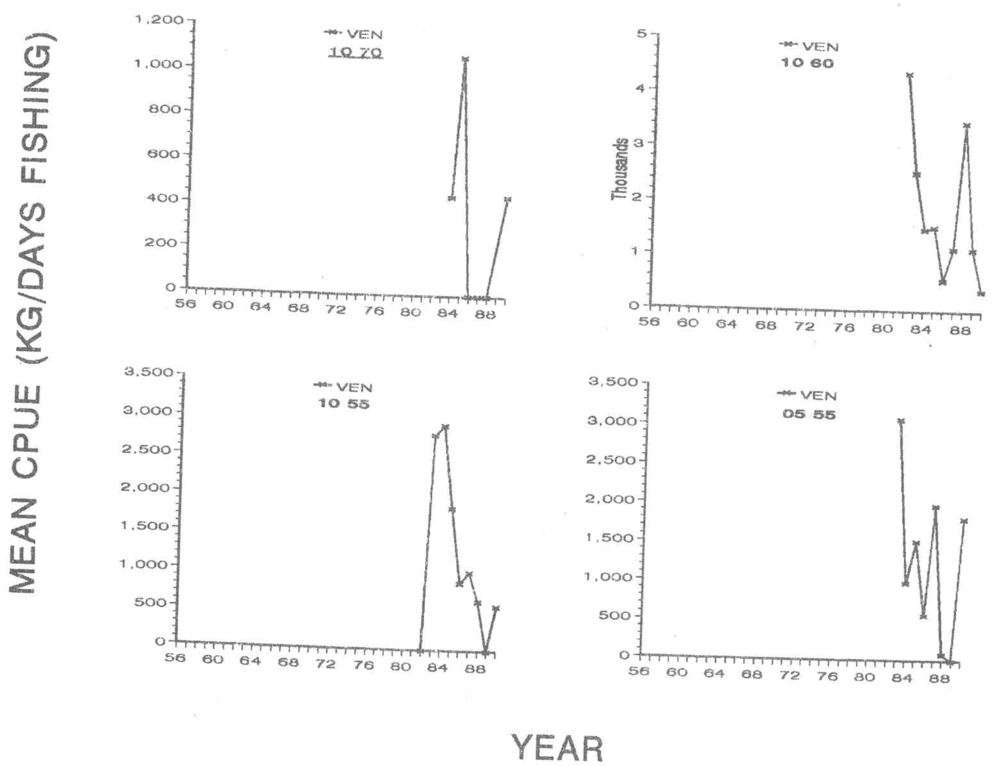

Figure 28. Changes in yearly mean baitboat CPUE (kg/days fishing) for skipjack tuna in specified five degree squares in the Caribbean region, during the period 1956-1990.

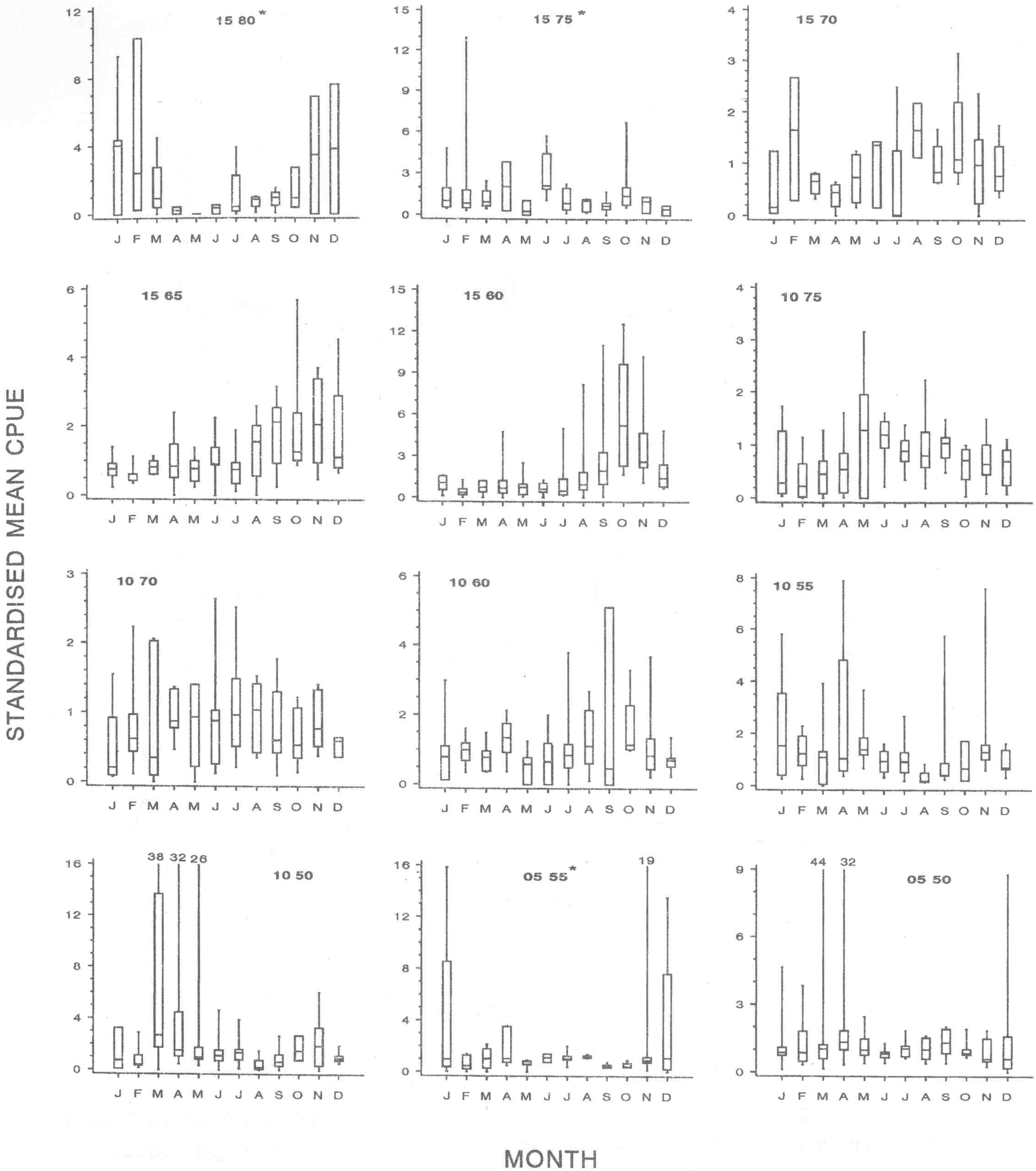

Figure 29. Changes in standardised monthly mean longline CPUE (where CPUE was recorded as no. fish/1,000 hooks) for yellowfin tuna in specified five degree squares in the Caribbean region during the period 1971-1990. For squares identified by *, monthly trends are shown for the entire period 1956-1990. In all plots, the full range of values is shown, i.e. the minimum to the maximum, with the box indicating the range of the core 50% values, and the position of the median represented by a horizontal line within the box.

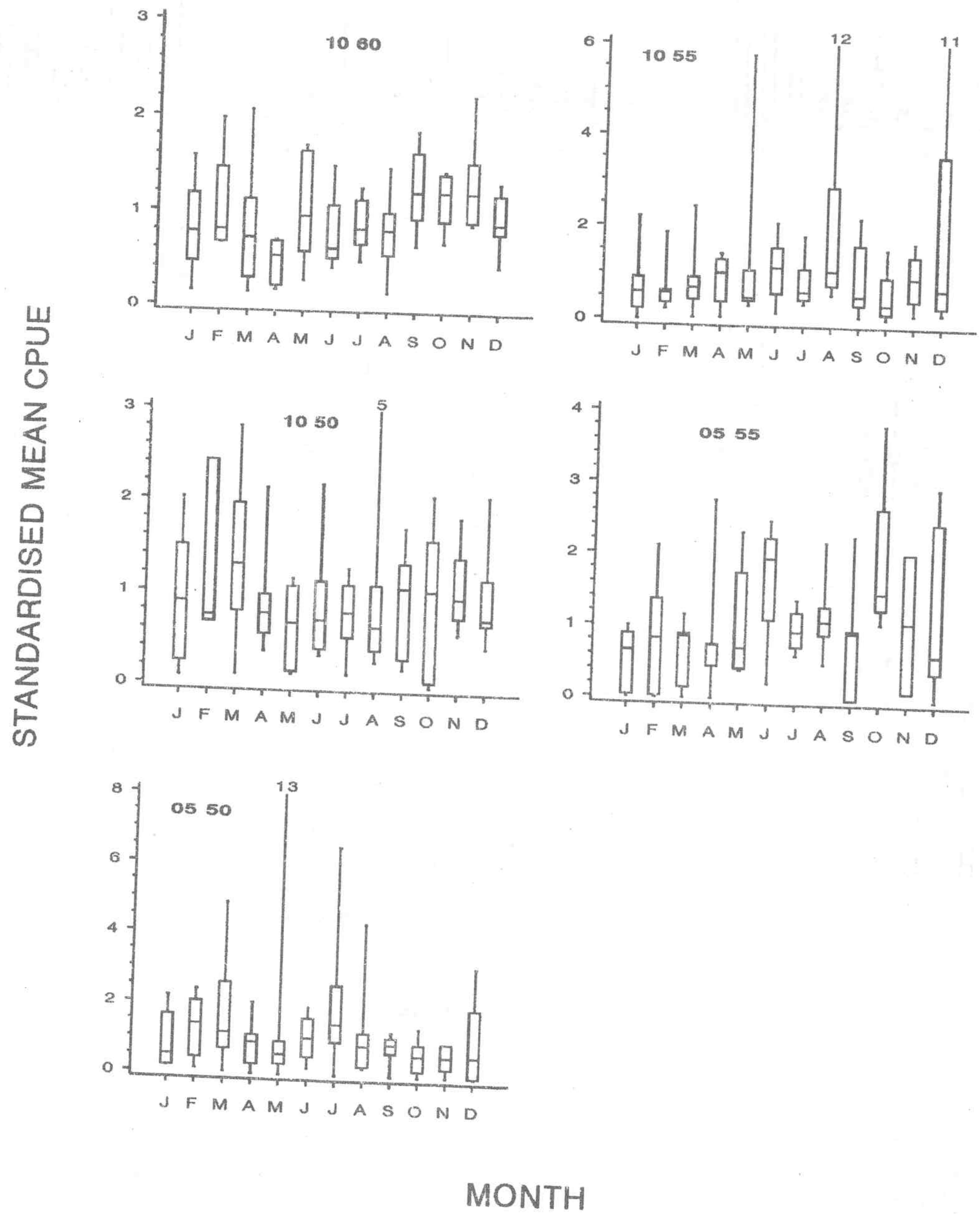

Figure 30. Changes in standardised monthly mean longline CPUE (where CPUE was recorded as kg/1,000 hooks) for yellowfin tuna in specified five degree squares in the Caribbean region during the period 1971-1990. In all plots, the full range of values is shown, i.e. the minimum to the maximum, with the box indicating the range of the core 50% values, and the position of the median represented by a horizontal line within the box.

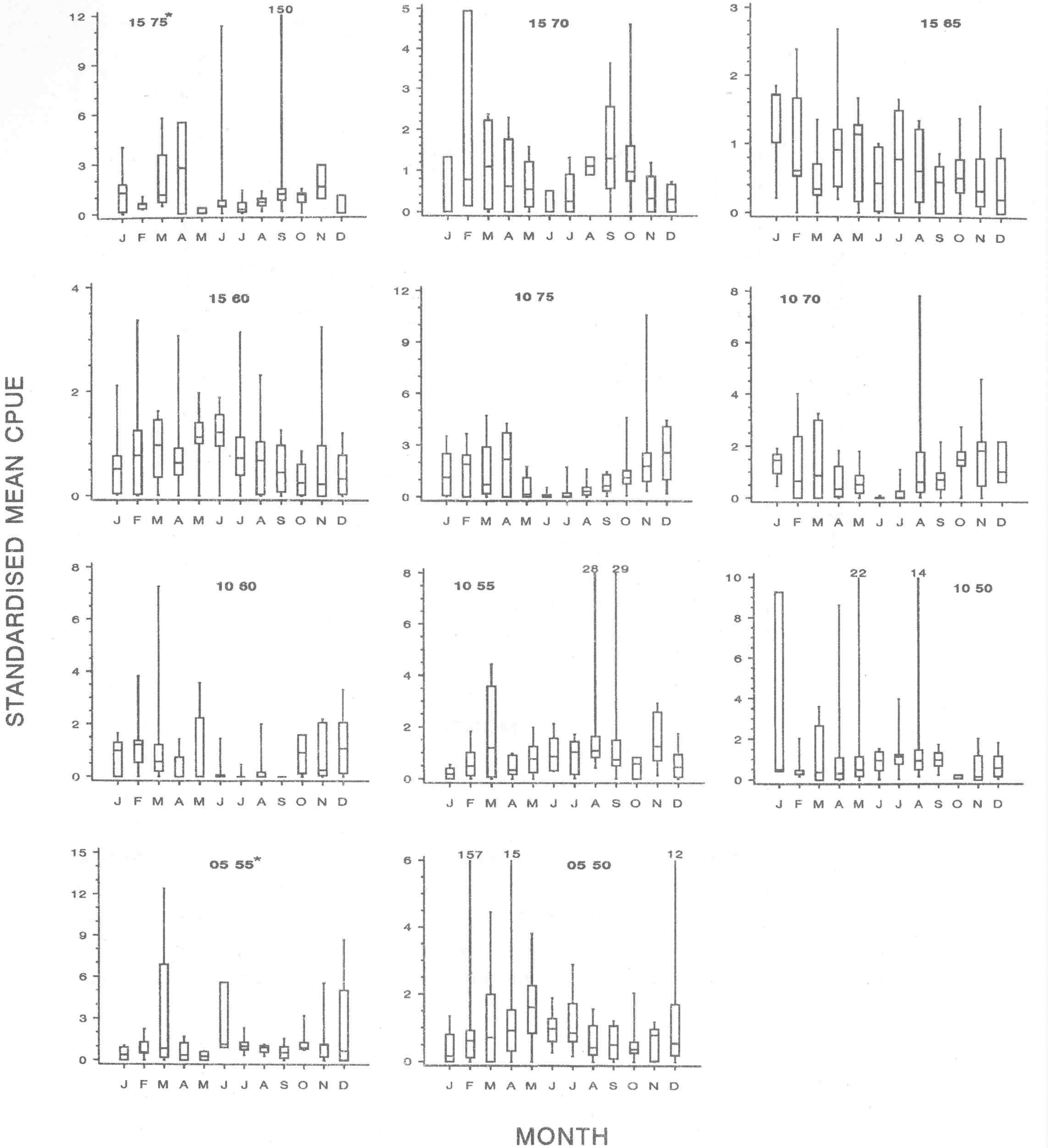

Figure 31. Changes in standardised monthly mean longline CPUE (where CPUE was recorded as no. fish/1,000 hooks) for albacore tuna in specified five degree squares in the Caribbean region during the period 1971-1990. For squares identified by *, monthly trends are shown for the entire period 1956-1990. In all plots, the full range of values is shown, i.e. the minimum to the maximum, with the box indicating the range of the core 50% values, and the position of the median represented by a horizontal line within the box.

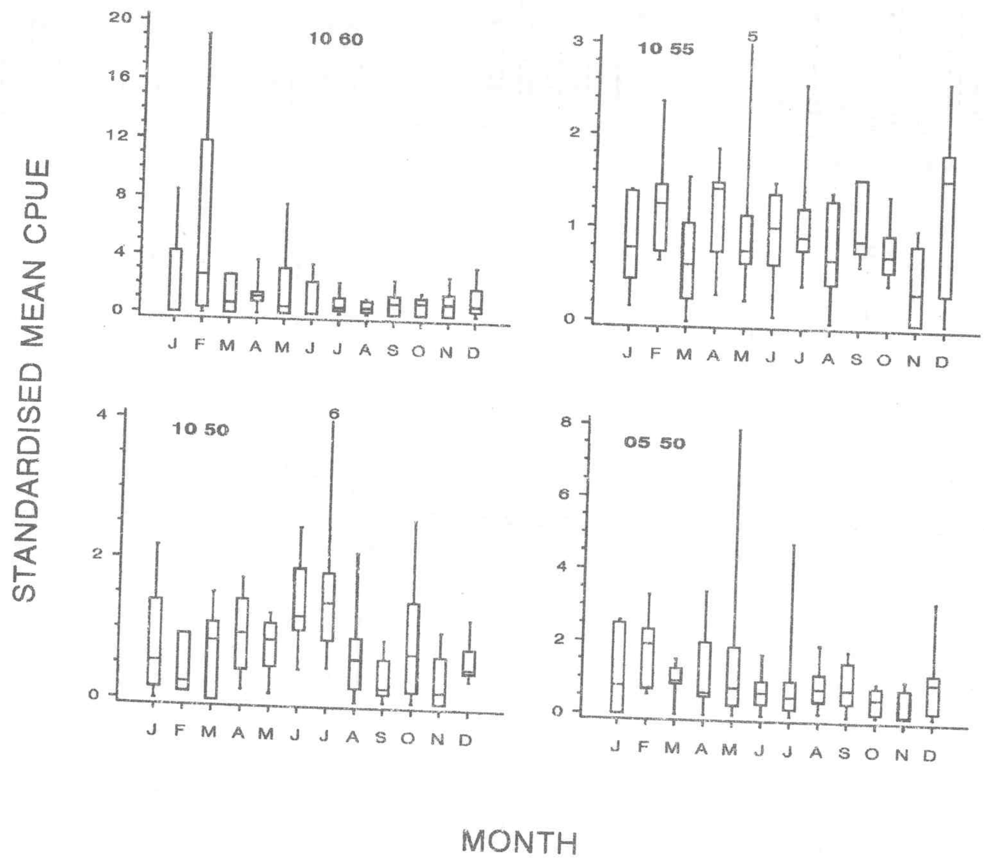

Figure 32. Changes in standardised monthly mean longline CPUE (where CPUE was recorded as kg/1,000 hooks) for albacore tuna in specified five degree squares in the Caribbean region during the period 1971-1990. In all plots, the full range of values is shown, i.e. the minimum to the maximum, with the box indicating the range of the core 50% values, and the position of the median represented by a horizontal line within the box.

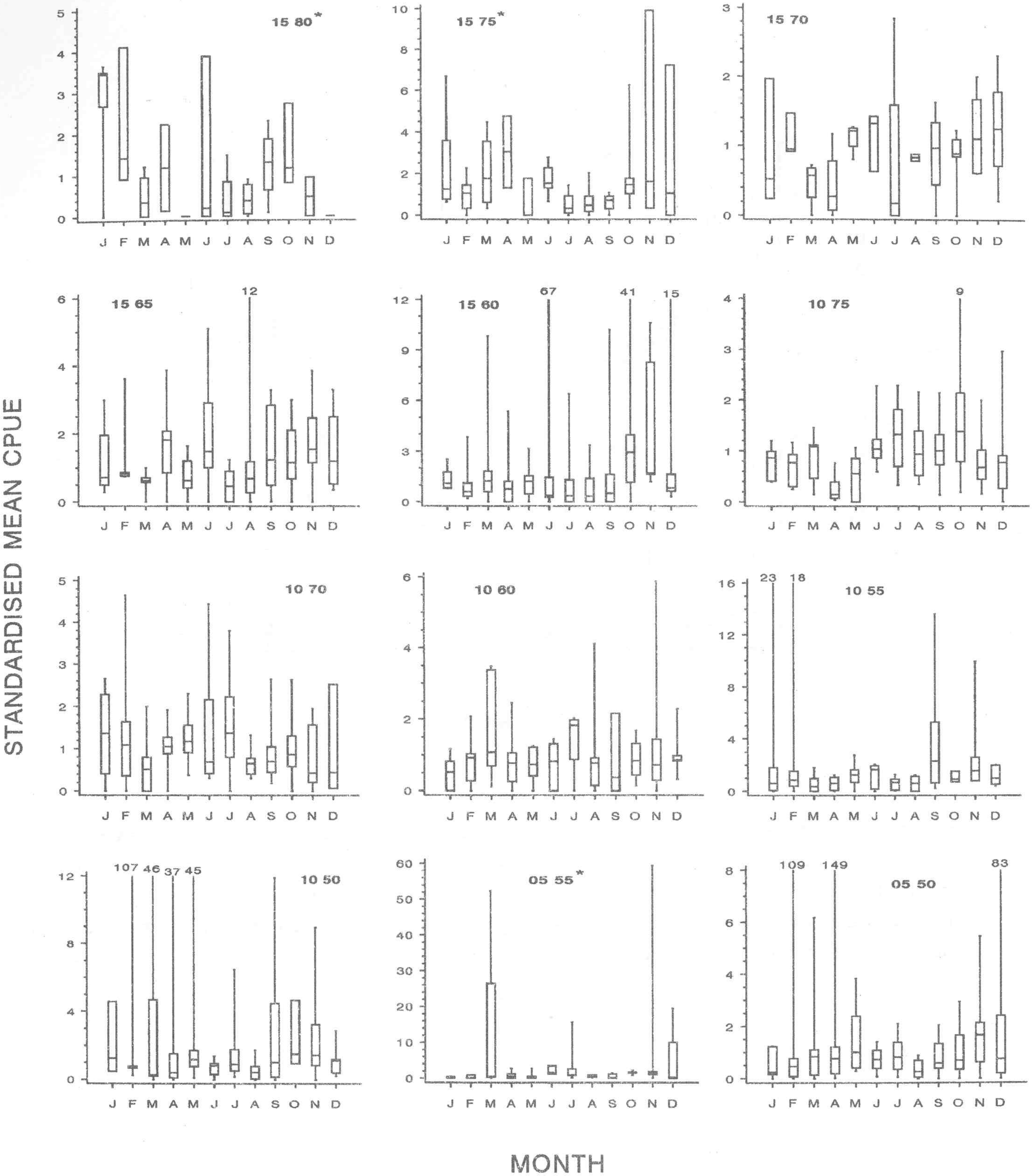

Figure 33. Changes in standardised monthly mean longline CPUE (where CPUE was recorded as no. fish/1,000 hooks) for bigeye tuna in specified five degree squares in the Caribbean region during the period 1971-1990. For squares identified by *, monthly trends are shown for the entire period 1956-1990. In all plots, the full range of values is shown, i.e. the minimum to the maximum, with the box indicating the range of the core 50% values, and the position of the median represented by a horizontal line within the box.

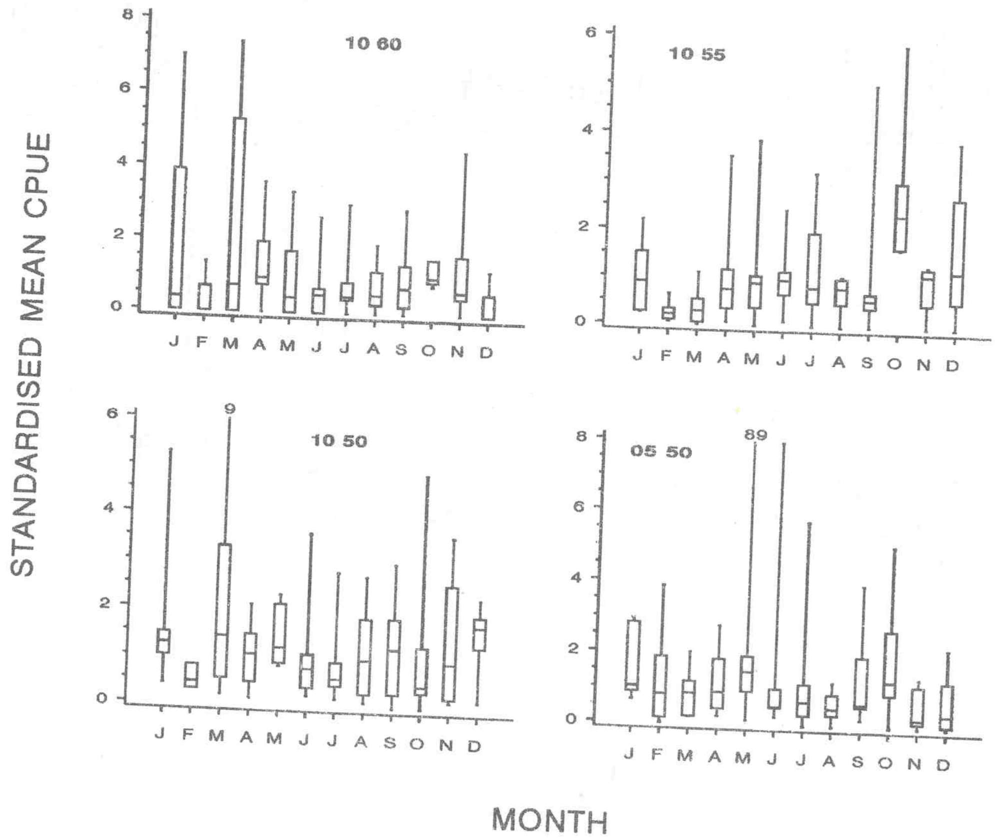

Figure 34. Changes in standardised monthly mean longline CPUE (where CPUE was recorded as kg/1,000 hooks) for bigeye tuna in specified five degree squares in the Caribbean region during the period 1971-1990. In all plots, the full range of values is shown, i.e. the minimum to the maximum, with the box indicating the range of the core 50% values, and the position of the median represented by a horizontal line within the box.

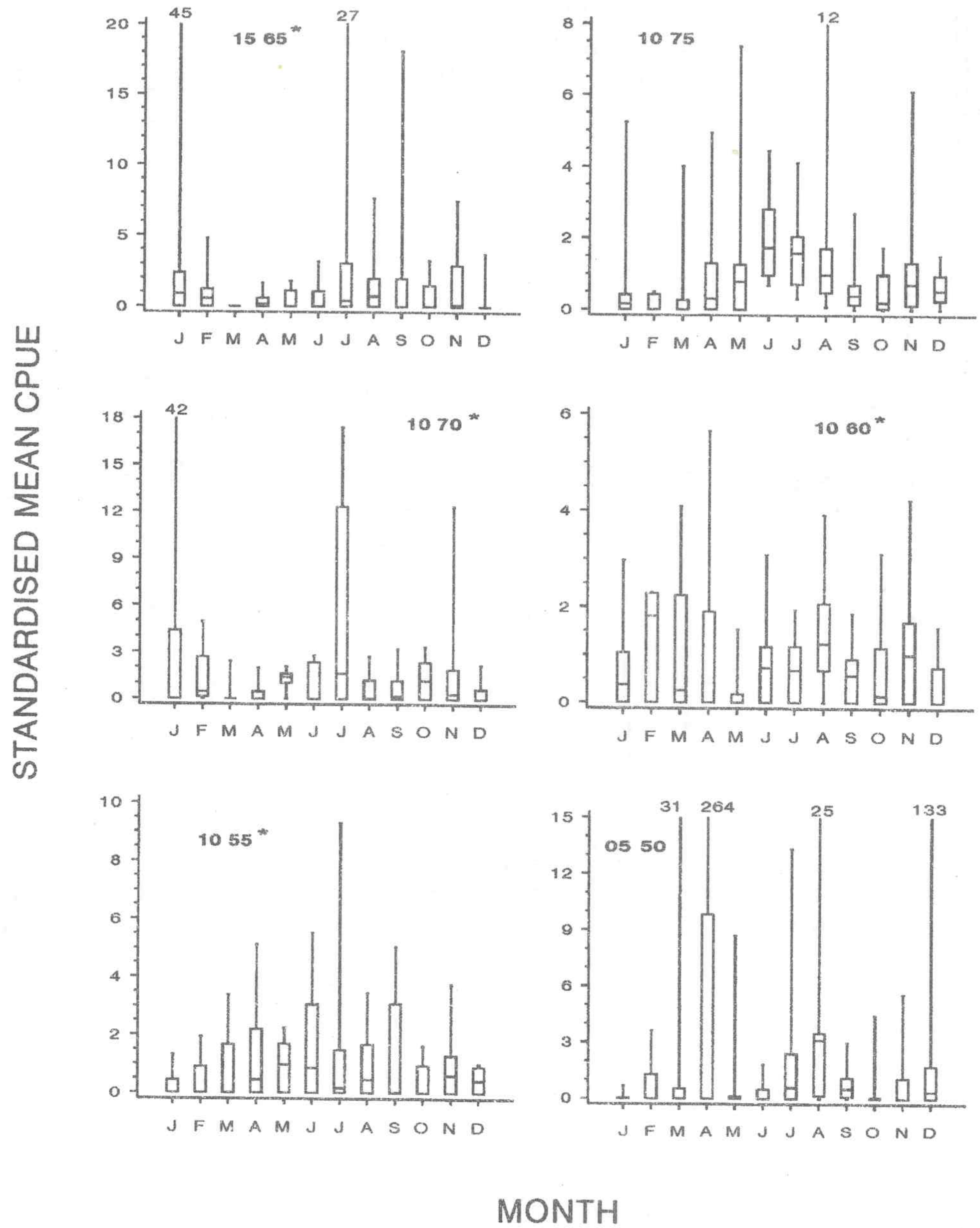

Figure 35. Changes in standardised monthly mean longline CPUE (where CPUE was recorded as no. fish/1,000 hooks) for sailfish in specified five degree squares in the Caribbean region during the period 1971-1990. For squares identified by *, monthly trends are shown for the entire period 1956-1990. In all plots, the full range of values is shown, i.e. the minimum to the maximum, with the box indicating the range of the core 50% values, and the position of the median represented by a horizontal line within the box.

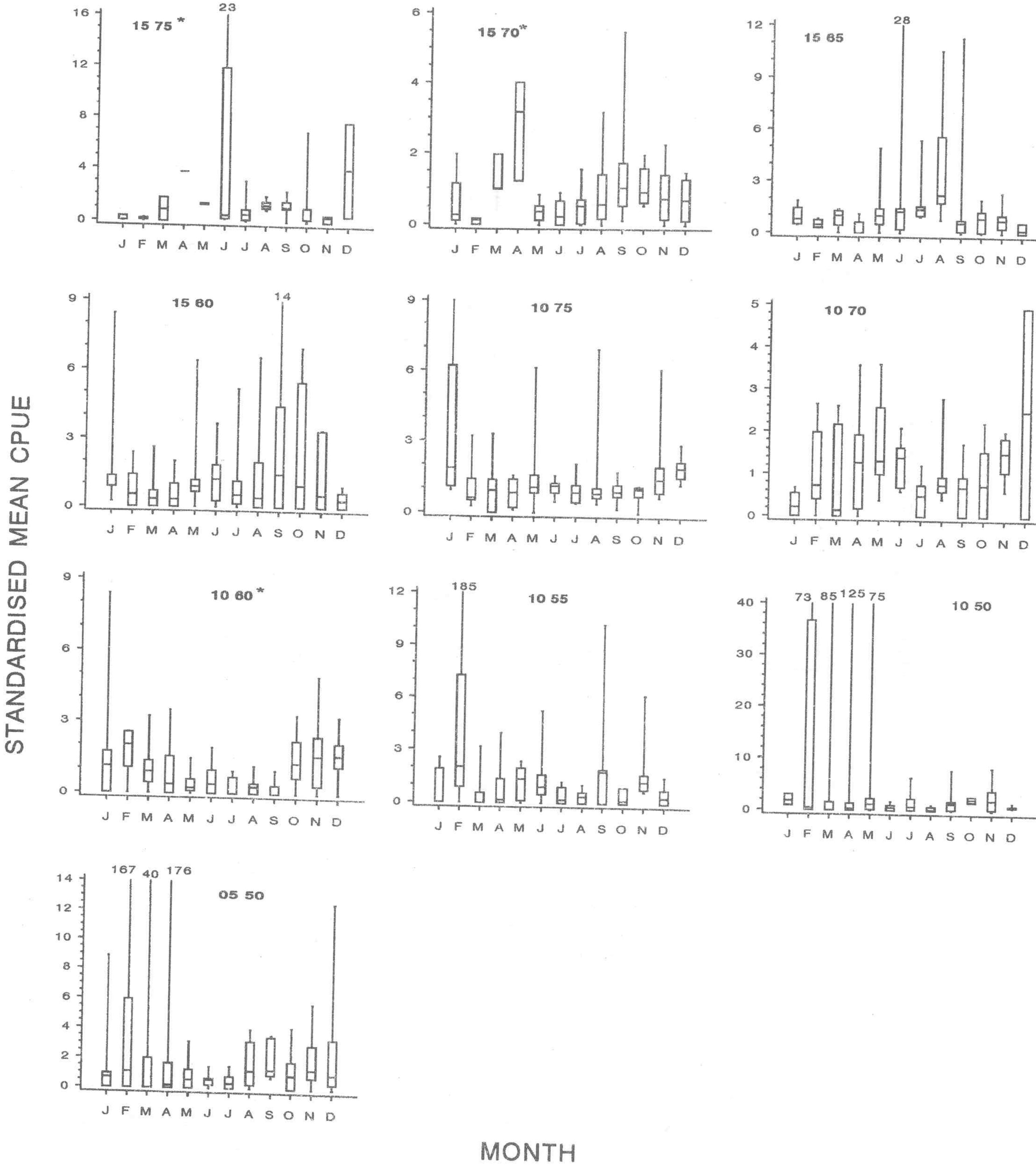

Figure 36. Changes in standardised monthly mean longline CPUE (where CPUE was recorded as no. fish/1,000 hooks) for blue marlin in specified five degree squares in the Caribbean region during the period 1971-1990. For squares identified by *, monthly trends are shown for the entire period 1956-1990. In all plots, the full range of values is shown, i.e. the minimum to the maximum, with the box indicating the range of the core 50% values, and the position of the median represented by a horizontal line within the box.

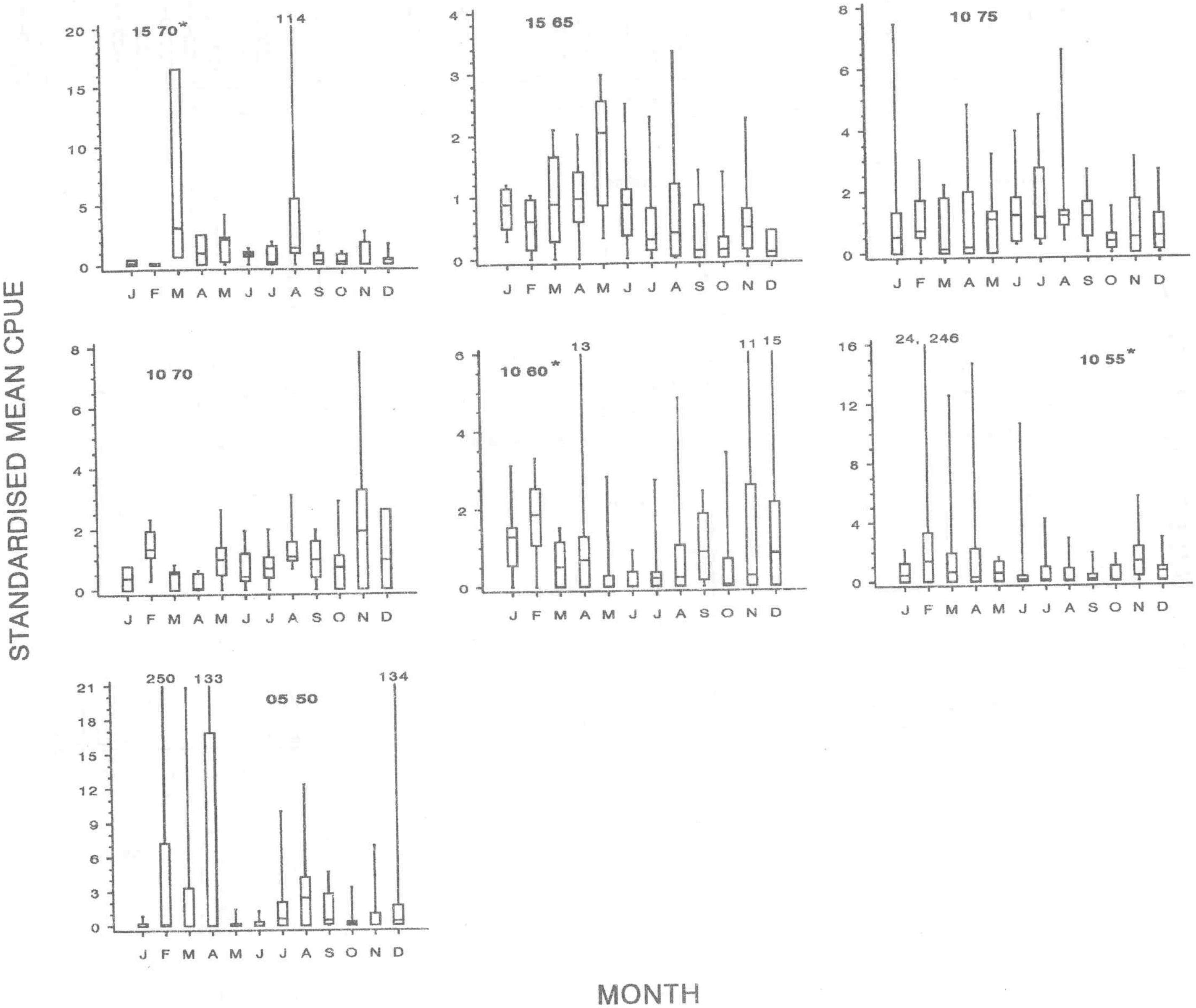

Figure 37. Changes in standardised monthly mean longline CPUE (where CPUE was recorded as no. fish/1,000 hooks) for white marlin in specified five degree squares in the Caribbean region during the period 1971-1990. For squares identified by *, monthly trends are shown for the entire period 1956-1990. In all plots, the full range of values is shown, i.e. the minimum to the maximum, with the box indicating the range of the core 50% values, and the position of the median represented by a horizontal line within the box.

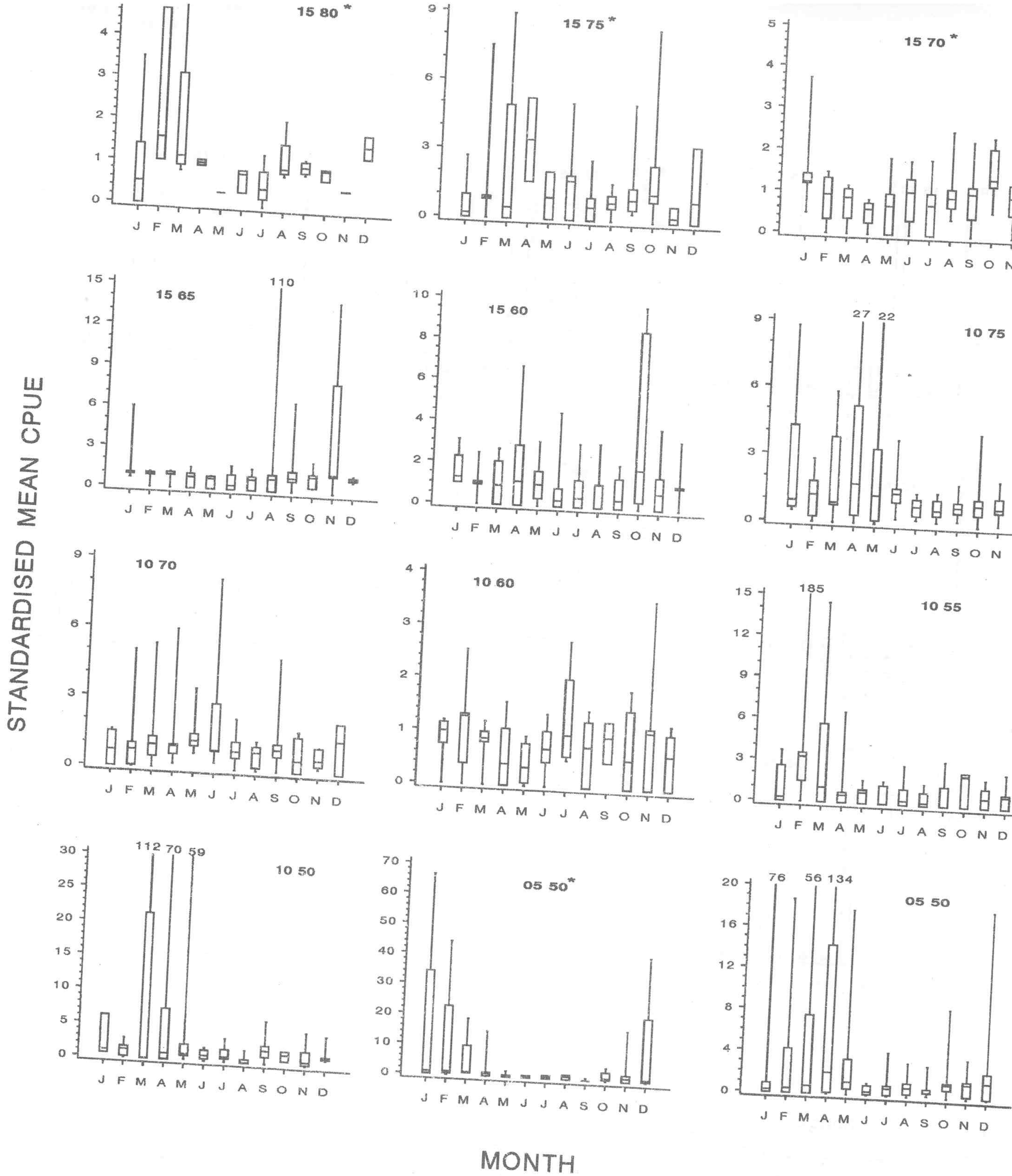

Figure 38. Changes in standardised monthly mean longline CPUE (where CPUE was recorded as no. fish/1,000 hooks) for swordfish in specified five degree squares in the Caribbean region during the period 1971-1990. For squares identified by *, monthly trends are shown for the entire period 1956-1990. In all plots, the full range of values is shown, i.e. the minimum to the maximum, with the box indicating the range of the core 50% values, and the position of the median represented by a horizontal line within the box.

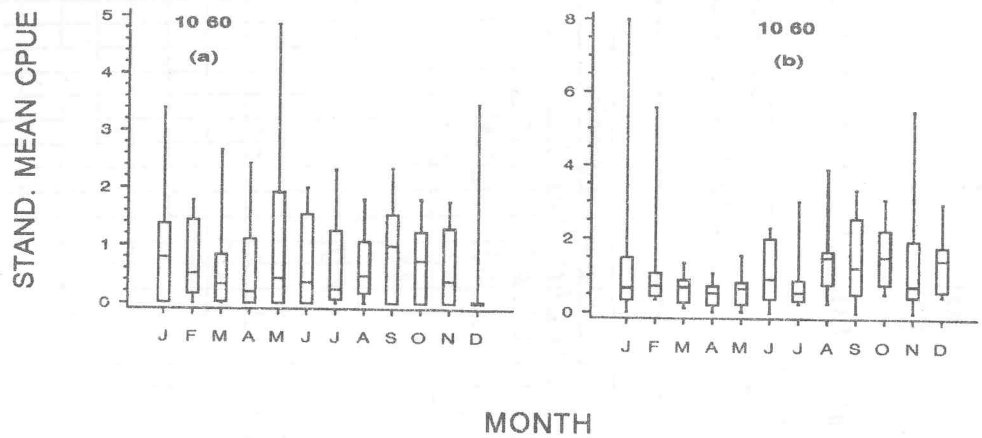

Figure 39. Changes in standardised monthly mean (a) purse seine and (b) baitboat CPUE (where CPUE was recorded as kg/days fishing) for yellowfin tuna in specified five degree square (10 60) in the Caribbean region during the period 1971-1990. In all plots, the full range of values is shown, i.e. the minimum to the maximum, with the box indicating the range of the core 50% values, and the position of the median represented by a horizontal line within the box.

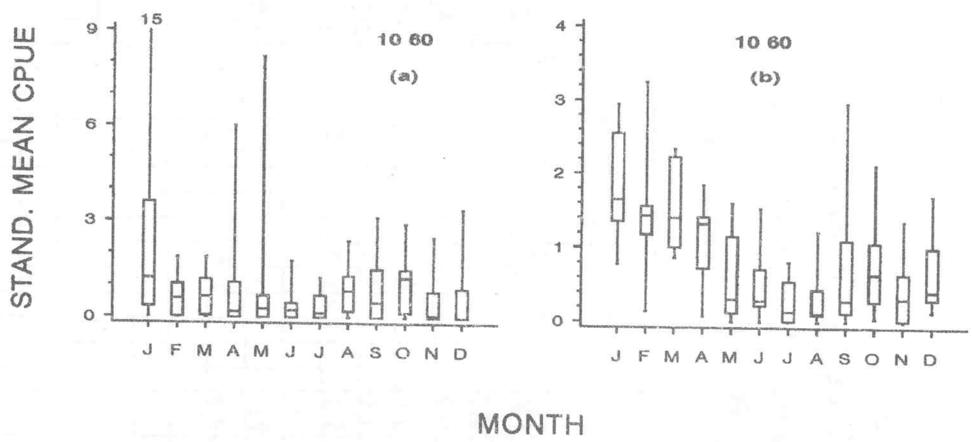

Figure 40. Changes in standardised monthly mean (a) purse seine and (b) baitboat CPUE (where CPUE was recorded as kg/days fishing) for skipjack tuna in specified five degree square (10 60) in the Caribbean region during the period 1971-1990. In all plots, the full range of values is shown, i.e. the minimum to the maximum, with the box indicating the range of the core 50% values, and the position of the median represented by a horizontal line within the box.

APPENDIX 1- SAMPLE OF ICCAT REPORTING FORM FOR TASK II CATCH AND EFFORT DATA.

ICCAT FORM 2
Rev. 1

ATLANTIC TUNA CATCH AND EFFORT STATISTICS BY AREA, MONTH, AND SPECIES (TASK 2)

Country: Korea
Flag: Korea
Gear: Longline (Foreign base)
Unit of effort: Number of hooks used
DATA: Sampled ☒ 100% coverage ☐ Coverage rate 74.2

Year 1975
Catch ☒ or landing ☐
Weight ☒ unit MT or number of fish ☐ Conversion factor
Round weight ☒ or in what condition
Conversion factor: YF · 1.30, Others: 1.13
Converted from: YF. Grilled & Gutted, Others Dressed

DATA: Quick estimate ☐ Estimate ☐ Preliminary ☒ Final ☐

Month	Size	Quadrant	Lat	Long	Effort	TOTAL	Bluefin *T.t. thynnus*	Yellowfin *T. albacares*	Albacore *T. alalunga*	Bigeye *T. obesus*	Skipjack *K. pelamis*	Swordfish *X. gladius*	Bonito *S. sarda*	Other species (specify): Sailfish	Other species (specify): White M.
01	6	1	00	000	2478	3.5	--	2.5	0.5	0.2	--	--	--	0.3	--
	6	1	05	000	7800	4.3	--	2.3	0.7	0.3	--	0.2	--	0.4	0.4
	6	4	05	005	10200	7.4	0.5	1.4	4.2	1.3	--	--	--	--	--
	6	4	05	045	7200	4.5	--	0.5	2.0	--	--	--	--	2.0	--
	6	3	15	035	8000	4.2	--	--	4.0	--	0.1	0.1	--	--	--
Subtotal					35678	23.9	0.5	6.7	11.4	1.8	0.1	0.3	--	2.7	0.4
02	6	1	05	005	7198	2.8	0.1	0.9	1.0	0.3	--	0.5	--	--	--
	6	1	05	010	13200	8.4	0.3	3.5	2.0	1.3	--	0.8	-	0.5	--

SAMPLE

APPENDIX 2 - ASCII FORMAT IN WHICH ICCAT DATA ARE RELEASED TO COUNTRIES.

FILE: c/e format for exchange   REGISTRO: 229 bytes/record

FILE TYPE ★	RECORD TYPE ★	YEAR	COUNTRY	GEAR	TIME STRATA	KIND SQUARE	QUADRANT	LATITUDE	LONGITUDE	PORT	KIND CATCH	KIND EFFORT	DATE	EFFORT	COVERAGE RATE %	# CATCHES ★	SPECIES	CATCH 1	SPECIES	CATCH 2	SPECIES	CATCH 3	SPECIES	CATCH 4	SPECIES
					10					20			30 DD-MM-YY	40			50	60		70		80		90	100

SPECIES	CATCH 6	SPECIES	CATCH 7	SPECIES	CATCH 8	SPECIES	CATCH 9	SPECIES	CATCH 1Ø	SPECIES	CATCHES 11 - 14	SPECIES	CATCH 15
	120		130		140		150		160				229

★ File type
- Ø unknown
- 1 basic
- 2 working group
- 3 confidential
- 4 reference
- 5 special
- 6 extra
- 7 Puerto Rico Tr.

★ Record type
- Ø without verification
- 1 data wrong
- 2 data okay

★ # catches value range Ø: 15
- if # catches less than 15 then rest of record is zero-filled up to 229 bytes
- must check for Ø catches for records with only effort data

30	40	50	60	70	80	90	100

FORMAT(2I1, I2, I3, 2(3I2, I1), I2, A8, F1Ø.1, F6.2, I2, 15(I2, F1Ø.1))

10	20	30	40	50	60	70	80	90	100

APPENDIX 3 - ICCAT DATA CODES USED AND EXPLANATIONS

Table A3.1 - File type codes used

Code	Description
0	Unknown
1	Basic (Data Record, Stat. Series)
2	Working Group
3	Confidential
4	Reference only
5	Special - to be used with type 1; there is no duplication
6	Extra: use after consultation (there is a duplication with type 1)
7	Puerto Rico Transshipments (there could be a duplication with type 1)
8	Adjusted basic

Table A3.2 - Country codes used

Code	Country
1	ALGERIA
2	ARGENTINA
3	BRAZIL
4	CANADA
5	CHINA (Taiwan)
6	CUBA
7	DENMARK
8	FRANCE
9	GERMANY
10	GREECE
11	ITALY
12	JAPAN
13	KOREA
14	LIBYA
15	MALTA
16	MOROCCO
17	NORWAY
18	POLAND
19	PORTUGAL
20	SOUTH AFRICA
21	SPAIN
22	SWEDEN
23	TUNISIA
24	TURKEY
25	UNITED STATES
26	YUGOSLAVIA
27	GHANA
28	PANAMA
29	VENEZUELA
30	GRENADA
31	MEXICO
32	FRANCE-IVOIRE-SÉNÉGALE (FIS)
33	MARTINIQUE
34	ANGOLA
35	USSR
36	GUADELOUPE
37	DOMINICAN REPUBL.
38	ISRAEL
39	LEBANON
40	SIERRA LEONE
41	TRINIDAD
42	URUGUAY
43	US VIRGIN IS.
44	GHANA B
45	CANARY B
46	KOREA+PANAMA
47	BULGARIA
48	CYPRUS
49	GERMAN EAST
50	CÔTE D'IVOIRE
51	LIBERIA
52	ROMANIA
53	SENEGAL
54	CHI.ICAT - China (Taiwan) ICCAT Port Sampling
55	JPN.ICAT - Port Sampling
56	BRAZIL (Korea)
57	BRAZIL (Japan)
58	P.RIC.TR - Foreign Transshipment to Puerto Rico
59	FRANCE (Spain)
60	EGYPT
61	ST. HELENA
62	COLOMBIA
63	BARBADOS
64	SYRIA
65	CAPE VERDE
66	IRELAND
67	BENIN
68	GABON
69	CONGO
70	NETHERLANDS
71	HONDURAS
72	TOGO
73	NOT ELSEWHERE INCLUDED (NEI)
74	CAYMAN ISLANDS
75	BRAZIL (Spain)
76	NLD. ANT.- Netherland Antilles
77	ST. LUCIA
78	GHA.ICAT - Ghana - ICCAT source
79	SAO TOME AND PRINCIPE
80	BRAS.CAY - Cayman Is. flat leased by Brazil
81	E.GUINEA - Equitorial Guinea
82	MAURITANIA
83	BERMUDA
84	CAMEROON
85	FOREIGN FLAG BASED IN VENEZUELA
86	JAPAN-CA-OB - Japan observed by Canada
87	JAPAN-US-OB - Japan observed by USA
88	NIGERIA
89	GHALMD - Ghana local market/discards
90	ARUBA
91	IT.TY.LI - Italy, Thyrrhenian-Ligurian seas
92	TUN.MON - Tunisia, Monastir
93	JPN.REF - Japan (reference)
94	G.BISSAU - Guinea Bissau
95	CAN.JAP.
96	CUB.ICAT - Cuba-ICCAT Port Sampling
97	JP-SH-OB - Japan observed by St. Helena
98	GERMANY
99	OTHERS

Table A3.3 - Description And Codings Of Fisheries (Gears)

Gear	Codes	Fishing	Descriptions
BB	17	Baitboat	Pole-and-line fishing while chumming live bait to attract tuna schools.
BBI	15	Baitboat ice-well	Relatively small size baitboat carrying catches in the fish well together with ice (see BB).
BBF	16	Baitboat-freezer	Relatively large size baitboat equipped with freezer.
GILL	24	Gill-net	A set of nets (either drifting or fixed to the bottom of the sea) used for gilling or entangling fish.
HAND	19	Hand-line	Lines held by hand with or without chumming live bait.
HARP	18	Harpoon	Fish are caught by throwing a harpoon or spear by hand or by auxiliary mechanism.
HS	29	Haul Seine	Beach seine. Fish are caught by seine hauled at beach.
LL	1	Longliner	A set of lines to which branch lines with hooks are attached.
LLD	33	Longliner (Discarded fish)	Special code used for fish caught by longliners but not retained (discarded to the sea).
LLFB	3	Foreign-based longliner	Longliner (see LL) operating from a port outside her flag country.
LLHB	4	Home-based longliner	Longliner (see LL) operating from a port of ;her flag country
LLMB	2	Deckloaded-type mother-boat longliner	A relatively large boat with one or more smaller boats carried aboard: these can be dispatched to the fishing ground to participate in longline fishing.
MWT	23	Mid-water trawl	A net which is immersed in water and then dragged for a certain period in mid-water (i.e the opening of the net does not touch the sea bottom).
MWTD	34	Double boat mid-water trawl	A mid-water trawl which is dragged by a pair of fishing boats.
PS	6	Purse seiner	Relatively large size seine with pursing mechanism at the bottom to close the net after fish school as encircled in the seine. The boat may carry a skiff as an auxiliary method of operation.
PSFB	25	Purse seiner (Big fish)	A special code to distinguish purse seiners (see PS) fishing large fish.
PSFS	26	Purse seiner (Small fish)	A special code to distinguish purse seiner (see PS) fishing small fish.

Gear	Codes	Fishing	Descriptions
PSG	5	Large size purse seiner	A purse seiner (see PS), having a fish holding capacity greater than 400 MT.
PSM	20	Medium size purse seiner	A purse-seiner (see PS), having a fish holding capacity between 150 and 400 MT.
PSS	7	Small size purse seiner	A purse seiner (see PS), having a fish holding capacity less than 150 MT.
PSD	8	Double-boat purse seiners	Two boats operating as a pair, fishing with a purse seine (see PS). The two boats contribute equally to the operation. Catches may be bailed to a third boat.
PSLB	21	Purse seiner with live bait	A purse seiner (see PS), using bait to hold schools of tunas. Bait may be used from the seiner or another boat specialising in chumming bait.
RR	22	Rod-and-reel	A rod and line fishing, while the line is operated with a rel attache to the rod (sport fishing type gear).
RRFB	27	Rod-and-reel (Big fish)	A rod-and-reel (see RR) catching mostly large fish.
RRFS	28	Rod-and-reel (Small fish)	A rod-and-reel (see RR) catching small fish only.
SPHL	31	Sport handline	Hand-line fishing (see HAND) by recreational fishermen.
SPOR	12	Sport fisheries unclassified	All unspecified fishing methods not carried out as a commercial activity, i.e. not with the intention of selling the catches for profit.
SURF	13	Surface fisheries unclassified	Any gear which catches tunas at surface or near surface area.
TRAP	10	Trap	Fixed gear anchored to the seabed. Generally composed of a guide net that leads tunas into an enclosure.
TRAW	14	Trawl	A net which is immersed in the water and then dragged for a certain period along the bottom of the sea.
TROL	9	Troller	A boat equipped with a line or lines, each having one or more hooks. Lines are trolled from the running boat either directly or held by a pole or poles.
UNCL	13	Unspecified methods	Any other fishing gears or methods not described above or gears which are unknown.

Table A3.4 - Species codes used

Codes		Scientific Name	English
1	BFT	*Thunnus thynnus thynnus*	Bluefin tuna
2	SBF	*Thunnus maccoyii*	Southern bluefin tuna
3	YFT	*Thunnus albacares*	Yellowfin tuna
4	ALB	*Thunnus alalunga*	Albacore
5	BET	*Thunnus obesus*	Bigeye tuna
6	BLF	*Thunnus atlanticus*	Blackfin tuna
7	LTA	*Euthynnus alleteratus*	Atlantic black skipjack
8	SKJ	*Katsuwonus pelamis*	Oceanic skipjack
9	BON	*Sarda sarda*	Atlantic bonito
10	FRI	*Auxis thazard*	Frigate tuna
11	BOP	*Orcynopis unicolour*	Plain bonito
12	WAH	*Acanthocybium solandri*	Wahoo
13	SSM	*Scomberomorus maculatus*	Spotted Spanish mackerel
14	KGM	*Scomberomorus cavalla*	King mackerel
15	SAI	*Istiophorus albicans*	Atlantic sailfish
16	BLM	*Makaira indica*	Black marlin
17	BUM	*Makaira nigricans*	Atlantic blue marlin
18	WHM	*Tetrapturus albidus*	Atlantic white marlin
19	SWO	*Xiphias gladius*	Broadbill swordfish
20	SPF	*Tetrapturus pfluegeri and T. belone*	Spearfish
21	OTH		Others
22	BGT		Big tunas unclassified
23	YOU		Young tunas
24	BIL	*Istiophoridae*	Billfishes unclassified
25	SMT		Small tunas unclassified
26	KGX	*Scomberomorus spp.*	Scomberormorus unclassified
27	SLT	*Allenthunnus fallai*	Slender Tuna
28	MAW	*Scomberomorus tritor*	West African Spanish mackerel
29	CER	*Scomberomorus regalis*	Cero mackerel
30	BLT	*Auxis rochei*	Bullet tuna
31	MIX		More than one species included in catch
	BRS	*Scomberomorus brasiliensis*	Serra Spanish Mackerel

OTH - Includes figures reported as "mixed species of tunas" or "unknown species".

Table A3.5 - Region codes used

0	EAST	East Atlantic - UNCL
1	NW	West Atlantic - North Temperate
2	WTRO	West Atlantic - Tropical
3	SW	West Atlantic - South Temperate
4	GOFM	Gulf of Mexico
5	WEST	West Atlantic - UNCL
6	ATL	UNCL - Atlantic
15	CVER	Cape Verde, vicinity
39	NWC	West Atlantic - North Central Temperate
40	NORT	UNCL - North Temperate
41	SOUT	UNCL - South Temperate
42	NE	East Atlantic - North Temperate
43	ETRO	East Atlantic - Tropical
44	SE	East Atlantic - South Temperate
45	CANA	Canary Islands, vicinity
46	VISC (BISC)	Bay of Biscay
47	MEDI	Mediterranean and adjacent seas
48	ATMED	Atlantic and Mediterranean catches reported together
58	TYRR	Tyrrhenian sea
59	LIGU	Ligurian sea
60	ADRI	Adriatic sea
61	TROP	UNCL - Tropical
62	AZOR	Azores, vicinity
63	MDRA	Madeira, vicinity

Table A3.6 - Time codes used

1-12	Months
13	1st QUARTER
14	2nd "
15	3rd "
16	4th "
17	YEARLY
18	Jan-June
19	July-Dec

Table A3.7 - Unit codes used

Code	Unit
1	METRIC TONS
2	SHORT TONS
3	NO. FISH
4	GG DWT R*
5	CONV. RD (Converted round weight)
6	FILET

Table A3.8 - Effort unit codes used

Code	Unit	
0	NO DATA	- Not available
1	D.FISH	- Days fishing
2	D.FISH.G	- Days at fishing ground
3	D.AT SEA	- Days at sea
4	NO.SETS	- No. of sets made
5	SUC.SETS	- Successful sets made
6	NO.TRIPS	- No. of trips made
7	NO.HOOKS	- No. of hooks
8	N.POLE-D	- No. of pole days
9	NO.LINES	- No. of lines used
10	NO.BOATS	- No. of boats
11	TRAP D.	- Trap days
12	FISH.HOUR	- No. of fishing hour
13	NO.TRAPS	- No. of traps
14	SUC.D.FI	- Successful days fishing

Table A3.9 - Area codes used

Code	Size of rectangle
0	no square available
1	5° lat x 10° long
2	10°lat x 20° long
3	10°lat x 10° long
4	20°lat x 20° long
5	1°lat x 1° long
6	5°lat x 5° long
7	USA area
8	BFWG area
9	ICCAT area
10	Region in lat only

* Gilled and gutted weight for large tunas, dressed weight for billfishes and round weight for small tunas.