THE CATCH STATISTICS OF THE BILLFISH FISHERY IN GHANA

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ABSTRACT

The artisanal "anifa-anifa" exploitation of the billfish resources in Ghanaian waters began in about 1974, but systematic collection and analysis of the catch by species began in 1984. The ICCAT Enhanced Research Programme for Billfish was initiated in Ghana in 1989 with the collection of catch statistics from three fishing villages in the Western Region of Ghana. The annual national catch statistics of the billfish was obtained from random sampling of the landings at eleven landing centres out of a total of 32 landing sites for the anifa-anifa fishery. A total of 366 canoes operate the anifa-anifa fishery at the 32 centres. The selection of the catch collection centres is based on a three-stage sampling survey system in which the sampling sites, sampling days and canoes are the primary, secondary and tertiary sampling units. The number of canoes whose catches should be sampled on any sampling day is selected according to a random table. The sampling for the ICCAT Enhanced Research Programme for Billfish was limited to three landing beaches, but the same random table for selecting the canoes for sampling as already mentioned, was used. In both methods, length /weight relationships were applied to convert the lower jaw-fork lengths to weights. There were quite annual wide fluctuations in fishing effort; so also were the total catch and catch per trip of each of the four species depicting an underlying decline from 1984 to 1991. The observed increases in fishing effort did not necessarily reflect equivalent increases in catch. The sailfish catches were most abundant of the four species being exploited. For the three-year period of the ICCAT Enhanced Research Programme for Billfish, the fishery exploited the same size ranges of each of the four species. There were more males than females of the marlins and the swordfish in contrast to the sailfish which had about the same quantity of males as females.

RESUME

L'exploitation artisanale "anifa-anifa" des ressources en istiophoridés dans les eaux ghanéennes a démarré en 1974, mais la collecte systématique et l'analyse de la capture par espèce a débuté en 1984. Le Programme ICCAT de Recherche intensive sur les Istiophoridés a été lancé au Ghana en 1989 par la collecte de statistiques de capture dans trois villages de pêcheurs dans la région ouest du Ghana. Les statistiques nationales annuelles de capture d'istiophoridés sont obtenues par échantillonnage aléatoire des débarquements dans onze des 32 centres de débarquement de la pêcherie anifa-anifa. En tout, 366 pirogues travaillent dans la pêcherie anifa-anifa dans ces 32 centres. La sélection des centres de collecte de données se fonde sur un système de prospection en trois stades selon lequel les lieux d'échantillonnage, le date d'échantillonnage et les pirogues constituent respectivement la première, deuxième et troisième unité d'échantillonnage. Le nombre de pirogues dont les prises doivent être échantillonnées un jour donné est retenu selon une table aléatoire. L'échantillonnage du Programme ICCAT de Recherche intensive sur les Istiophoridés s'est limité à trois plages de débarquement, mais en utilisant la même table aléatoire mentionnée ci-dessus pour sélectionner les pirogues pour l'échantillonnage. Avec les deux méthodes, des rapports longueur-poids ont été appliqués pour convertir la longueur

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maxillaire en poids. L'effort de pêche présentait des fluctuations annuelles assez amples; la prise totale et la prise par sortie de chacune des quatre espèces montraient également une baise sous-jacente de 1984 à 1991. L'accroissement de l'effort de pêche observé n'était pas forcément reflété par une augmentation équivalente des prises. Les prises de voilier étaient les plus abondantes des quatre espèces exploitées. Pendant les trois années du Programme ICCAT de Recherche intensive sur les Istiophoridés, la pêcherie a exploité la même gamme de taille de chacune des quatre espèces. Les istiophoridés et l'espadon comportaient plus de mâles, contrairement au voilier qui présentait plus ou mois la même quantité d'individus des deux sexes.

RESUMEN

La explotación artesana "anifa-anifa" de los recursos de marlín en aguas de Ghana se inició alrededor del año 1974, pero la recogida sistemática y análisis de la captura por especies, empezó en 1984. El Programa ICCAT de Investigación Intensiva sobre Marlines, comenzó en Ghana en 1989 con la recogida de estadísticas de captura en tres aldeas de pescadores en la región occidental de Ghana. Las estadísticas nacionales de captura anual de marlines se obtuvieron por medio de muestreo aleatorio de los desembarques en once puntos, de un total de 32, de la pesquería anifa-anifa. Esta pesquería se compone de 366 canoas que faenan en los 32 centros. La selección de los centros de recogida de capturas se basa en un sistema de muestreo en tres etapas, en el cual las zonas de muestreo, días de muestreo y las canoas, constituyen las unidades de muestreo primaria, secundaria y terciaria. El número de canoas, cuyas capturas han de ser muestreadas en un día determinado, se selecciona de acuerdo con una tabla aleatoria. En el marco del Programa ICCAT de Investigación Intensiva sobre Marlines, el muestreo se limitó a tres playas, pero se aplicó la misma tabla aleatoria de muestreo mencionada en el caso de la selección de canoas. En ambos métodos, se aplicaron las relaciones talla /peso para convertir en peso la longitud mandíbula inferior-horquilla. En el esfuerzo de pesca había una amplia fluctuación anual, y también en la captura total y en la captura por salida, de cada una de las cuatro especies, lo cual refleja un descenso subyacente, de 1984 a 1991. Los aumentos observados en el esfuerzo de pesca no representaban necesariamente aumentos equivalentes en la captura. De las cuatro especies explotadas, la captura mas abundante fue de pez vela. En el curso de los tres años del Programa ICCAT de Investigación Intensiva sobre Marlines, la pesquería explotó los mismos rangos de talla de cada una de las cuatro especies. Se obtuvo una mayoría de machos en el caso de marlines y pez espada, mientras que en el caso del pez vela, se obtuvo prácticamente la misma cantidad de machos que de hembras.

1. INTRODUCTION

Four main species of billfishes occur in the coastal waters of Ghana. These are *Istiophorus platypterus* (sailfish), *Makaira nigricans* (blue marlin), *Tetrapturus albidus* (white marlin) and *Xiphias gladius* (swordfish) which are exploited by the artisanal "nifa-nifa" drifting gill-net fishery.

The fishery began in the Western Region of Ghana in about 1974 (Mensah and Doyi, 1992). However, serious systematic collection and analysis of the catch of this fishery did not begin until 1984. In 1984, not only the statistical sampling of the catch of this fishery was incorporated into the normal statistical sampling scheme of the general artisanal fishery by the Research and Utilization Branch of the Fisheries Department but also the billfish was sampled by species.

Then in 1985, the International Commission for the Conservation of Atlantic Tunas (ICCAT) adopted the ICCAT Enhanced Research Programme for Billfish but it was in 1987 that the first field work began. In Ghana, the ICCAT Enhanced Research Programme for Billfish began in 1989.

This report presents the results of the analysis of the catch and effort statistics of the artisanal billfish fishery in Ghana as well as the results of ICCAT Enhanced Research Programme for Billfish.

2. THE CATCH STATISTICS OF THE BILLFISH FISHERY IN GHANA

2.1 Methods for Statistical Sampling of the Billfish Catches

The results of the Ghana Canoe Frame Survey conducted in 1989 have shown that there were 8052 canoes operating different gears from 192 fishing villages with a total of 264 landing beaches along a coastline of 550 km long. Of these, 366 canoes were operating the drifting gill-net from 28 fishing villages with 32 landing beaches (Koranteng 1990). Collection of landing statistics is, therefore, carried out by sampling rather than total coverage or census. For this reason, canoe frame surveys are conducted periodically to form the basis for estimating artisanal catches.

The statistical sampling for billfish catches forms part of the statistical sampling programme for the artisanal fleet landings by the Research and Utilization Branch of the Fisheries Department, as has been described by Koranteng (1989) and which is summarised as follows:

A three-stage sampling survey system is used. The coastline is divided into four strata which correspond to the country's four coastal administrative regions as already mentioned (Figure A).

2.1.1 First Stage Sampling or Primary Sampling Units (PSU): Sampling Sites

Within each region, a number of fishing villages are selected on the basis of the number of fishing units (canoes) present. They are selected with probability proportional to the size (PPS) of the sampling unit (canoe). These constitute the primary sampling units (PSU).

Out of the 192 fishing villages and 264 landing beaches, 53 landing beaches (sites) have been selected as sampling sites at which 35 field enumerators (Technical Assistants) are located.

At each selected landing site, the canoes are substratified into the types of gears that are operated there. Some of the gears at the selected sampling sites are examined. In this selection process, the importance and consistency of operation of each gear at the selected site are taken into consideration. Where there are more than one Technical Assistant (especially at the large centres) all gears are sampled.

On the basis of this, the sampling sites for the drifting gill-net fishery are: one in the Volta Region, three each in the Greater-Accra and Central Regions and four in the Western Region, making a total of eleven. In other words, out of the 32 landings sites for the drifting gill-net fishery, eleven are sampled for total catch assessment.

2.1.2 Second Stage Sampling or Secondary Sampling Units (SSU): Sampling Days

Every month, each target gear at a recording site is sampled for two weeks. Where two gears are handled by one Technical Assistant, he records one gear each week in alternate weeks; the pattern is reversed in the following month. For each gear records are taken for at least four days in a sampling week. This approach is applied in the recording of the catches of the drifting gill-net fishery.

2.1.3 Third Stage Sampling or Tertiary Sampling Units (TSU): Canoes

For any gear, the canoes (or gears in the case of beach seines) at the landing site constitute the tertiary sampling units (TSU). The recorder selects some of the canoes that return from fishing and enumerate their landings.

2.1.3.1 Selection of Canoes for Sampling

Selection of canoes for examination is based on the numbers of canoes that actually operate at the centre on the sampling day. They are selected according to the order of arrival of the canoes from the fishing grounds. Each Technical Assistant is provided with a chart which guides him in the selection of the canoes to be examined. The number of canoes to be sampled on any sampling day is thus variable. A random table is used to select the canoes to be sampled.

(i) For 5 or less canoes, all are sampled
(ii) Between 5 and 10 canoes, 1 in 2 but not less 5 are sampled.
(iii) Between 11 and 20 canoes, 1 in 3 but not less than 6 are sampled.
(iv) Between 21 and 28 canoes, 1 in 4 but not less than 6 are sampled.
(v) Between 29 and 40 canoes, 1 in 5 but not less than 6 are sampled.
(vi) Between 41 and 50 canoes, 1 in 6 but not less than 7 are sampled.
(vii) Over 50 canoes, 1 in 10 but not less than 7 are sampled.

2.1.3.2 Data Recorded

(i) For a selected drifting net canoe, the following data are recorded:
(a) The lower jaw-fork length of each specimen of billfish landed is measured.
(b) The duration of the trip in hours
(c) The number of crew
(d) Value of each species in the catch

(ii) The actual number of drifting net canoes that landed on the sampling day.

2.1.3.3 Estimation of the Weight of the Billfish Landed.

The weight of each billfish landed is obtained from the lower jaw - fork length by applying the relevant statistical length-weight relationships reported in ICCAT
Collective Volumes of Scientific Papers (Volumes XV and XXVII; SCRS Volume XVIII) for areas that are sufficiently close to or include Ghanaian waters, as follows:

Length - Weight Relationships (All weights in kg; all lengths in cm)

A. Sailfish (*Istiophorus platypterus*)

$W = 3.04 \times 10^{-6} Lo^{3.163}$ (Lo = eye fork length and
$Lo = 0.896 L_{J-F}^{-6.891}$ L_{J-F} = Lower-Jaw Fork Length)

B. Swordfish (*Xiphias gladius*)

$W = 0.28833 \times 10^{-5} L_{J-F}^{3.2623}$

C. Blue marlin (*Makaira nigricans*)

$W = 2.2836 \times 10^{-5} Lo^{2.88411}$ and
$Lo = 0.88 L_{J-F}^{-1.89}$

D. White marlin (*Tetrapturus albidus*)

$W = 3.8755 \times 10^{-5} Lo^{2.70850}$ and
$Lo = 0.83 L_{J-F}^{+3.00}$

However, it should be pointed out that where the lower jaw-fork length was less than 136 cm or more than 188 cm, the length - weight relationship did not hold - the resulting weights were either too small or too large. However, only one or two such instances were encountered in this work.

For each sampling site, the estimated catch for the month is given by: $C = D/d\ X$
where D is the number of days in the month, excluding non-fishing days, d is the number of days on which samples were obtained and X is the estimated total catch at the centre for the d days.

This figure obtained is then divided by the number of units (canoes operating the drifting gill-nets) at the recording centre, to provide a mean catch for the drifting gill-net canoes at the particular centre. The means from all centres in the region where the same gear is sampled are then combined to provide an overall mean of means for the region. This is then multiplied by the number of similar units (canoes)

in the region as recorded in the frame survey. A national estimate is obtained by combining the regional estimates.

3. RESULTS

Based on the above estimation, Table 1 and Figures 1, 2 and 3 were prepared showing the annual catches of billfish by species and fishing effort for the period 1984 to 1991.

3.1 Fishing Effort

The fishing effort showed fluctuations which peaked in 1987. The minimum effort was exerted in 1991 (Figure 1)

3.2 Catches

The sailfish dominated the catch; but for its very low value in 1986, the sailfish catch showed a constant but gradual decline since 1984 (Figure 2 and Table 1). The marlins together (white and blue) were second in importance followed by the swordfish.

The total catch of billfish per trip was highest in 1984 which was just under 60 kg. (Figure 3). The value fluctuated during the following three years to its lowest value in 1987. Then, except for 1988, the catch per trip showed a gradual increase from 33 Kg in 1989 to 40 Kg in 1991.

4. DISCUSSION

4.1 Trends in the Catch and Fishing Effort

Of the four species, the sailfish constitutes the highest catch followed by the blue marlin, the swordfish and the white marlin in a decreasing order. In all four species, there are quite annual wide fluctuations which show an underlying decline in total catch and catch per trip from 1984 to 1991. Such wide fluctuations are also shown in the fishing effort (Figure 1). The increases in fishing effort do not necessarily reflect equivalent increases in catch. For instance, though the effort peaked in 1987, the total catch and catch per trip were highest in 1984 (Figures 1, 2 and 3).

The stock size of the billfish in Ghanaian waters is not known, so also is the availability of the species in relation to the coastal oceanography. However, judging from the efficiency with which the artisanal fishermen carry out the fishery, one can consider that the catches made by the fleet are a fair indication of the stock situation and the availability of the species to the gear. If this is so then it is likely that the billfish resources in Ghanaian waters are being heavily exploited as indicated in Figures 2. In Figure 3 and Table 1 there is an indication of a gradual recovery of the billfish resources, where except for 1988 there was a gradual increase in catch per trip and the fishing effort also shows a gradual decline in the last three years (1989-1991). An objective study of the stock size of the billfish will enhance a better management of the fishery in the coastal waters of Ghana.

5. ICCAT ENHANCED RESEARCH PROGRAMME FOR BILLFISH: 1989-1991

5.1 Method

The ICCAT Enhanced Research Programme for billfish was instituted in Ghana in March 1989. It is being carried out in accordance with the guidelines put forward by the programme. Axim was selected as the sampling center, but the author sampled at two other centers, namely, Dixcove and Apam (see Figure A) where the Research and Utilization Branch of the Fisheries Department has trained enumerators for other species of fish as well.

ICCAT Form B was used. Selection of canoes for sampling followed the same manner as already described. Since billfish is landed whole, lower jaw-fork lengths were measured using the tapes provided by the programme, and round weights estimated from the length-weight relationships as already described. The catch per day is obtained from the catch of the number of canoes sampled and the number that operated on the particular day according to the formula:

$C = Y/X*W$ where,

W = total weight of species landed on a particular day by the number of canoes sampled
X = number of canoes sampled
Y = total number of canoes operated on the particular day

6. RESULTS

6.1 Nominal Effort and Total Catch

Figure 4 shows the trend in the nominal effort over the three-year period (1989-1991). Within the fluctuations in the nominal effort, there was an underlying decline since March 1990 till December 1991. This trend is again reflected in Figure 5 where the monthly total catch does not necessarily show a direct linear relationship with the numbers of trips per month.

6.2 Total Catch per Trip

However, in Figure 6 after wide fluctuations beginning from July 1989, the catch per trip stabilised at low levels between September 1990 and November 1991; there was a substantial increase in the following month, December. A clear peak in catch per trip occurred in August and September 1989; for the rest of the period, a peak is not observed.

6.3 Catch per month by Species

Figures 7a - 7d show monthly catches, separately, of the four species by sex and total. For sailfish (Figure 7a) four peaks are observed of which the second peak which occurred in September 1989 was the highest. The other peaks occurred in April 1989, April 1990 and March 1991. The monthly catches of blue marlins (Fig. 7b) also show four peaks. These occurred in November 1989, March and September 1990 and September 1991. The trend in the white marlin (Fig.7c.) follows a similar pattern as in the blue marlin.

Swordfish monthly catches (7d) were the least and most infrequent of the four species.

6.4 Monthly Catch Per Trip

Of the four species under consideration, the monthly catch per trip for the sailfish was the highest. Sailfish catches were made almost every month throughout the period. Except in September 1989 and December 1991 when the monthly catch per trip was above 250 kg. the values were 100 kg. or less for the rest of the period (Fig.8a). Besides these two high values, there were three observable peaks. These were in April 1989, May and December, 1990.

The monthly catch per trip for the blue marlin showed four distinct peaks which were all below 250 kg; other monthly catches per trip were below 100 kg. (Figure 8b). The occurrence of the blue marlin in the catches was nearly as frequent as the sailfish.

The white marlins were less frequent than the blue marlin and the catches per trip were less than 50 kg. (Fig. 8c); it was only in three months, July, August 1989 and September 1990, that the catch per trip was more than 30 kg.

The swordfish was the least common. The monthly catch per trip showed fluctuations from July 1989 towards a decline to November 1991 (Fig.8d).

6.5 Length Frequencies and Sex Ratios

In order to find out any particular trend in the length frequency distribution of the four species of billfish under investigation for the three-year period, series of histograms have been drawn (Figures 9-14).

(i) Figures 9a - 9l show the monthly length frequency distribution of sailfish (both sexes put together) for the three-year period (1989 - 1991) for all the three centres put together.

(ii) Figures 10a - 10f show the length frequency distribution of sailfish (males and females separately and then put together) for all three centres pooled together by year. The total includes fish whose sexes could not be determined.

(iii) The corresponding parameters are presented in Figures 11a - 11f, 12a - 12f and 13a - 13f for blue marlin, white marlin and swordfish respectively.

(iv) Figures 14a - 14d show the histograms of mean lengths of the four species separately but all the three centres put together and by year. Also shown is the weighted mean length of each species for the three-year period.

All the figures indicate that the fishery exploited the same size ranges of each of the four species for the three-year period. The weighted mean lengths of the four species are as follows:

Sailfish	182.8 cm
Blue marlin	275.3 cm
White marlin	239.1 cm
Swordfish	220.3 cm

Total number of fish measured and sexed together with the sex ratios are recorded in Table 2.

Thus, with the exception of the sailfish for which there were as many females as males, the other species had more males than females.

7. DISCUSSION

Generally, the data presented (Figures 4 - 8) show a decline in fishing effort from 1989 to 1991 and stabilisation of monthly total catch at levels lower than in 1989. However, the last four months in 1991 appear to show an average moderate increase in the monthly total catch of the billfishes. A number of reasons could be assigned to this situation.

There is a general complaint by fishermen against lack of the appropriate netting and accessories for constructing new and repairing old nifa-nifa nets, and also unavailability of less expensive outboard motors. This might have contributed to the decline in fishing effort.

There is also the second reason which is due to the frequency of dangers the fishermen are exposed to at sea. There is the fear of fishermen getting lost if the outboard motor fails to function or the fishermen being run over by ocean going ships in the night. To solve some of these problems, fishermen have been advised to have on board two outboard motors or one outboard motor and a sail. But the fishermen find the outboard motors too expensive.

In addition, there is the likelihood that the lower catches of the billfish may act as a disincentive to go to sea more often. If this is so, then one may suggest that the stock level of the billfish has run down as also explained in 4.1. In this wise, the moderate average increase in monthly catches during the last four months in 1991 is an indication of a gradual recovery of the stock resulting from reduced number of trips over the past period of over one year.

However, the three-year size frequency distributions in the catches (Figures 9-14) show that the same size ranges of each of the four species were caught. These indicate that the fishing pressure on the stocks is about right or adequate so that the rate of recruitment is about the same as rate of

exploitation. It also indicates that the gear is suitable for the exploitation of the species and that there is no danger of exploiting undersize fish which may lead to unsustainable exploitation.

8. COMPARISON OF THE RESULTS OF THE SAMPLING SCHEMES OF THE RESEARCH AND UTILIZATION BRANCH OF THE FISHERIES DEPARTMENT AND THE ICCAT ENHANCED RESEARCH PROGRAMME FOR BILLFISH

(i) Both results show an underlying declining trend in fishing effort over the period.

(ii) Both results show that catches of sailfish were most abundant followed by the marlins (blue and white) put together; the swordfish was least abundant

(iii) Both results show that the total billfish catches stabilised at low levels with a moderate increase in the last three years (1989 - 1991).

9. SUMMARY

(i) Considering the results of the sampling scheme of the Research and Utilization Branch of the Fisheries Department, the following were observed:

a. The sailfish catches were most abundant, followed by the blue marlin, the swordfish and the white marlin in a decreasing order.

b. There were fluctuations in fishing effort, total catch and catch per trip; all these show an underlying decline from 1984 to 1991.

(ii) As regards the results of the ICCAT Enhanced Research Programme for Billfish, the following were observed:

a. Underlying the fluctuations in fishing effort was a decline from 1989 to 1991.
b. In 1990 and 1991, there was a stabilization of monthly total catch at levels lower than in 1989.
c. The last four months in 1991 appear to show an average moderate increase in the monthly total catch of billfish.
d. Monthly catch per trip for the sailfish was the highest followed by the marlins (white and blue put together) and the swordfish.
e. There were more males than females of white and blue marlins and swordfish in contrast to the sailfish which had about the same quantity of males as females.
f. For the three-year period (1989-1991) the fishery exploited the same size ranges of each of the four species.
g. The weighted mean lengths of the four species were as follows:
sailfish - 182.8 cm, blue marlin - 275.3 cm, white marlin - 239.1 cm, swordfish - 220.3 cm

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Table 1. Billfish landings in weight (MT) and effort (No. of trips).

YEAR	SPECIES				Total	Total	Catch per
	Sailfish	Swordfish	Blue marlin	White marlin	Catch	Effort	Trip
1984	1657.90	14.90	-	-	1672.80	28655	0.06
1985	1497.10	24.60	-	-	1521.70	33964	0.05
1986	925.20	23.00	21.60*		959.80	19218	0.05
1987	1391.61	122.89	6.41*		1520.91	48165	0.03
1988	869.98	234.90	87.91*		1192.79	28585	0.04
1989	465.36	155.50	430.28	68.06	1119.20	33469	0.03
1990	406.12	145.61	324.10	30.65	906.48	26076	0.04
1991	462.65	73.37	125.65	172.21	678.88	18887	0.04

* Blue and White Marlins were not separated.

Table 2. Numbers of fish measured and sexed, and sex ratios.

Species	Year	Number of fish Measured	Sex ratios male/female
Sailfish	1989	505	
Sailfish	1990	496	1.01
Sailfish	1991	615	
Blue marlin	1989	85	
Blue marlin	1990	84	1.42
Blue marlin	1991	32	
White marlin	1989	22	
White marlin	1990	22	2.06
White marlin	1991	11	
Swordfish	1989	19	
Swordfish	1990	16	1.86
Swordfish	1991	10	

Table 3. Billfish catches (in kgs) in all three centres combined.

Months	No. trips	SAILFISH			BLUE MARLIN			WHITE MARLIN			SWORDFISH		
		M	F	Total	M	F	Total	M	F	Total	M	F	Total
1989													
Jan.													
Feb.													
Mar.	5	114.1	165.0	279.1									
Apr.	294	7671.8	13365.8	21037.6	591.8	507.9	1099.7	136.2	453.7	589.9			
May	81	2723.7	2908.1	5631.8	157.4		157.4						
Jun.	72	1885.5	1912.4	3797.9	1361.2	490.4	1851.6		184.1	184.1			
Jul.	175	620.9	1240.8	1861.7	1642.6	8032.2	9674.8	5338.8	3129.1	8467.9	10563.5	921.8	11485.3
Aug.	86				13746.1	6328.6	20074.7	1061.7	1678.5	2740.2	189.0	231.2	420.2
Sep.	147	10041.6	31156.1	41197.7									
Oct.	184	2169.8	865.1	3034.9	14908.9	7212.9	22121.8		333.9	333.9	9918.8	781.1	10699.9
Nov.	111	2616.6	2077.4	4694.0	6870.2	530.4	7400.6	109.8		109.8	2019.8		2019.8
Dec.	171	5261.2	5414.7	10675.9	3154.2	1750.8	4905.0					672.9	672.9
1990													
Jan.	217	6859.5	7277.7	14137.2	2846.5	611.9	3458.4	208.1	82.4	290.5	273.6	860.7	1134.3
Feb.	202	7466.4	2898.0	10364.4	12018.9	4176.6	16195.5	2074.7	232.0	2306.7	4760.3	3974.4	8734.7
Mar.	244	8454.3	5927.9	14382.2	7567.9	3558.1	11126.0	4220.0		4220.0		1220.1	1220.1
Apr.	20	483.3	759.0	1242.3	1272.6	1151.8	2424.4		239.7	239.7			
May	88	3757.8	4921.8	8679.6		1964.1	1964.1						
Jun.	82	545.2	1062.8	1608.0	720.0	210.0	930.0		106.9	106.9			
Jul.	29				6923.8		6923.8						
Aug.	110	387.0	1051.3	1438.3	8029.0	4511.7	12540.7		789.6	789.6	2689.4	280.0	2969.4
Sep.	111				1904.8	5205.3	7110.1	5121.2		5121.2	2107.7		2107.7
Oct.	134	1941.7	2651.5	4593.2	6356.9	2109.8	8466.7	446.1		446.1		139.9	139.9
Nov.	132	3106.1	3592.6	6698.7	268.5	474.4	742.9	234.0	171.3	405.3			
Dec.	80	3467.2	3880.5	7347.7									
1991													
Jan.	136	3264.1	6250.4	9514.5	2604.7	269.7	2874.4	166.9	150.8	317.7			
Feb.	166	5718.2	6100.6	11818.8									
Mar.	144	4044.3	4135.7	8180.0	2304.5	949.0	3253.5		143.0	143.0			
Apr.	140	4379.4	5682.3	10061.7	3709.3		3709.3	635.2		635.2	364.0		364.0
May	43	1223.7	2223.7	3447.4									
Jun.	24	738.7	578.0	1316.7				146.4	101.4	247.8			
Jul.	58	121.8	903.0	1024.8	869.6		869.6					226.8	226.8
Aug.	71	665.0	1157.2	1822.2	1101.0	1335.5	2436.5	1680.9		1680.9		1031.3	1031.3
Sep.	62	915.6	919.0	1834.6	7636.0		7636.0				93.6		93.6
Oct.	114	3013.6	2673.7	5687.3		6394.3	6394.3	2940.9		2940.9	93.6		93.6
Nov.	134	4523.7	4574.6	9098.3	242.2	2192.5	2434.7		849.8	849.8		139.5	139.5
Dec.	21	5046.5	4238.5	9285.0									

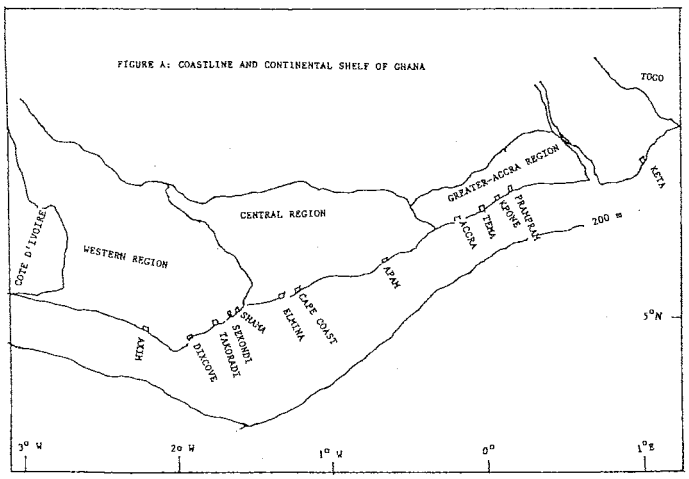


Fig. A Coast line and continental shelf of Ghana.

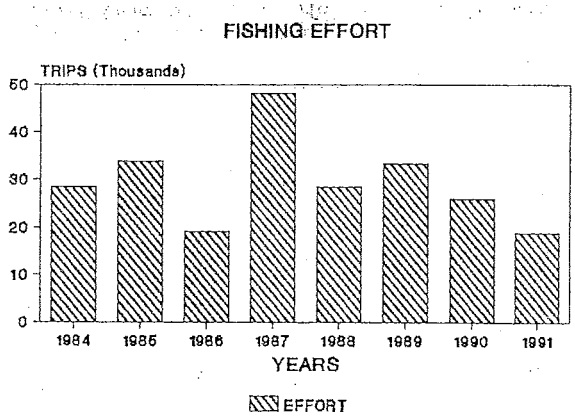


Fig. 1 Ghanaian billfish fishing effort, 1984-1991.

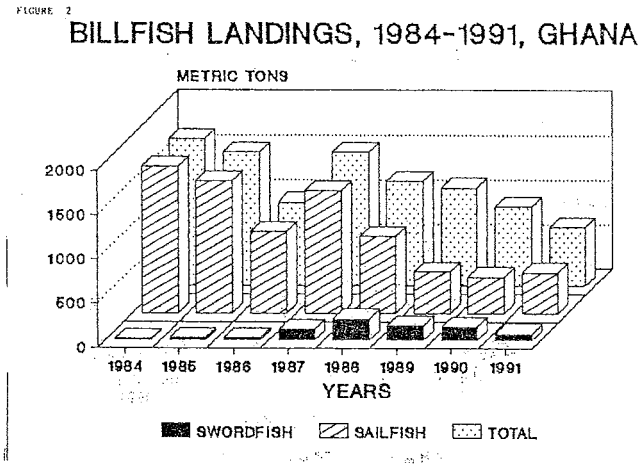


Fig. 2 Ghanaian billfish landings, 1984-1991.

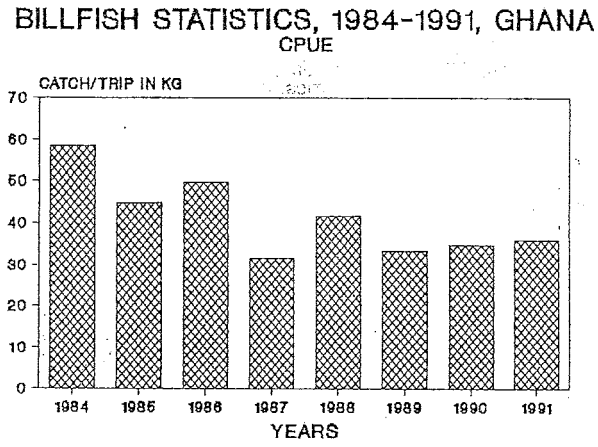


Fig. 3 Ghanaian catch per unit of effort for billfsih, 1984-1991.

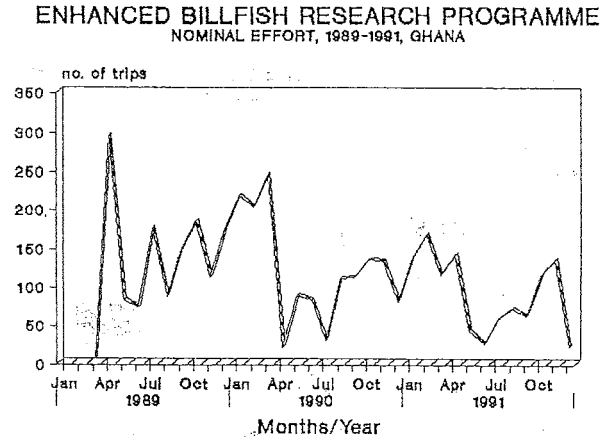


Fig. 4 Ghanaian nominal monthly effort for billfish, 1989-1991.

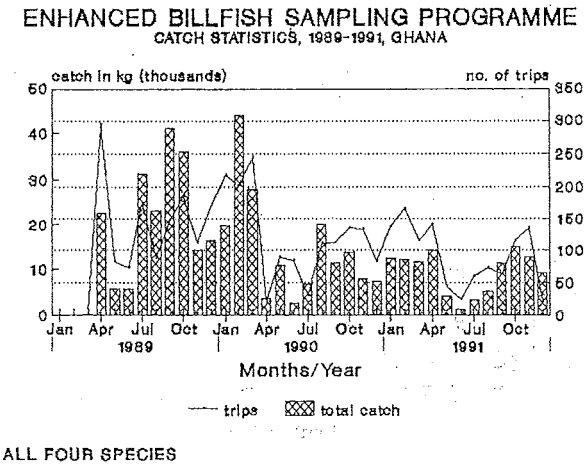


Fig. 5 Ghanaian monthly billfish catch and effort, 1989-1991.

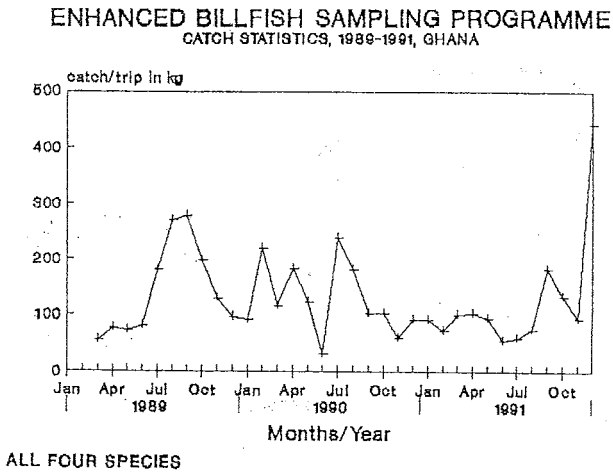
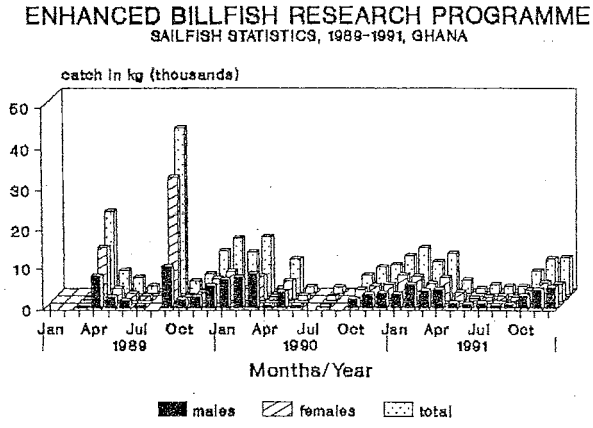
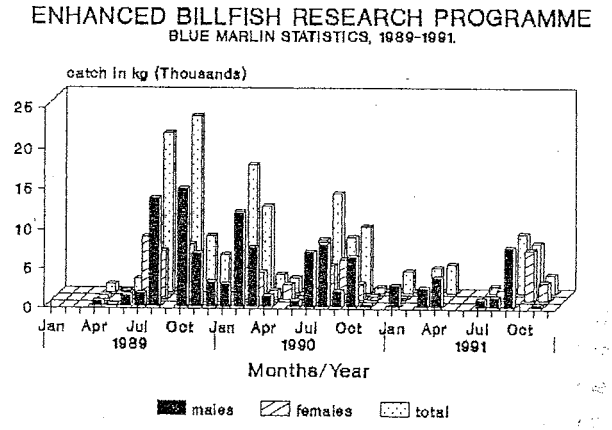


Fig. 6 **Ghanaian billfish monthly catch per trip, 1989-1991.**

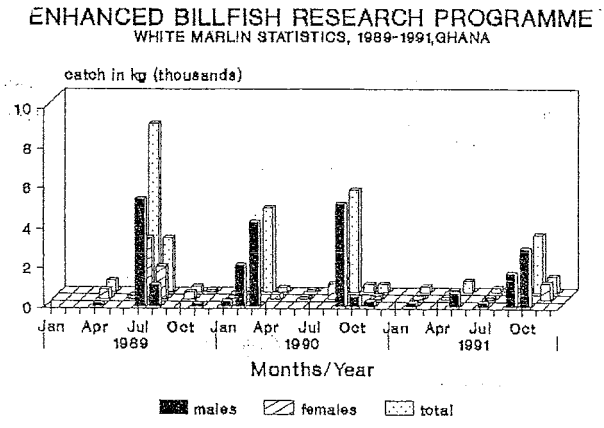
a) Sailfish



b) Blue marlin



c) White marlin



d) Swordfish

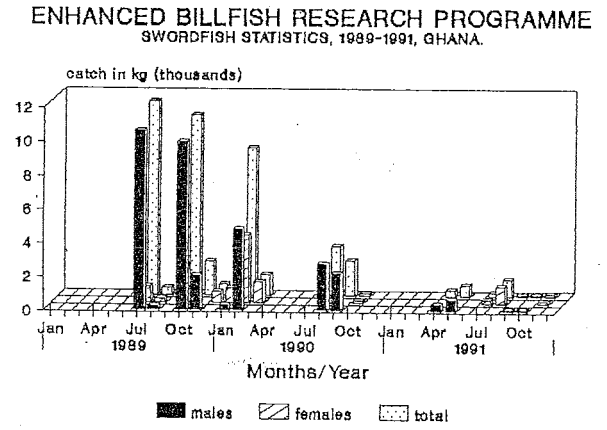


Fig. 7 **Ghanaian monthly billfish catches by species, 1989-1991.**

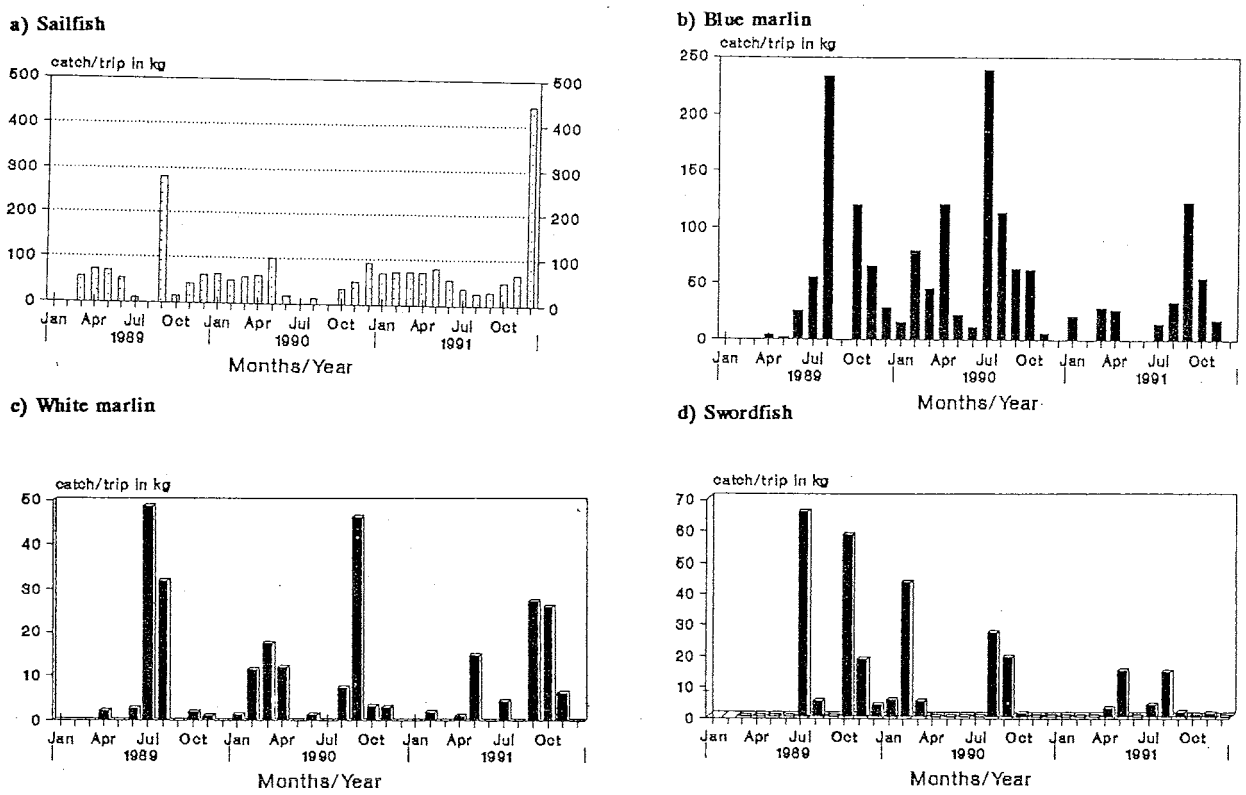


Fig. 8 Ghanaian monthly billfish catch per trip by species, 1989-1991.

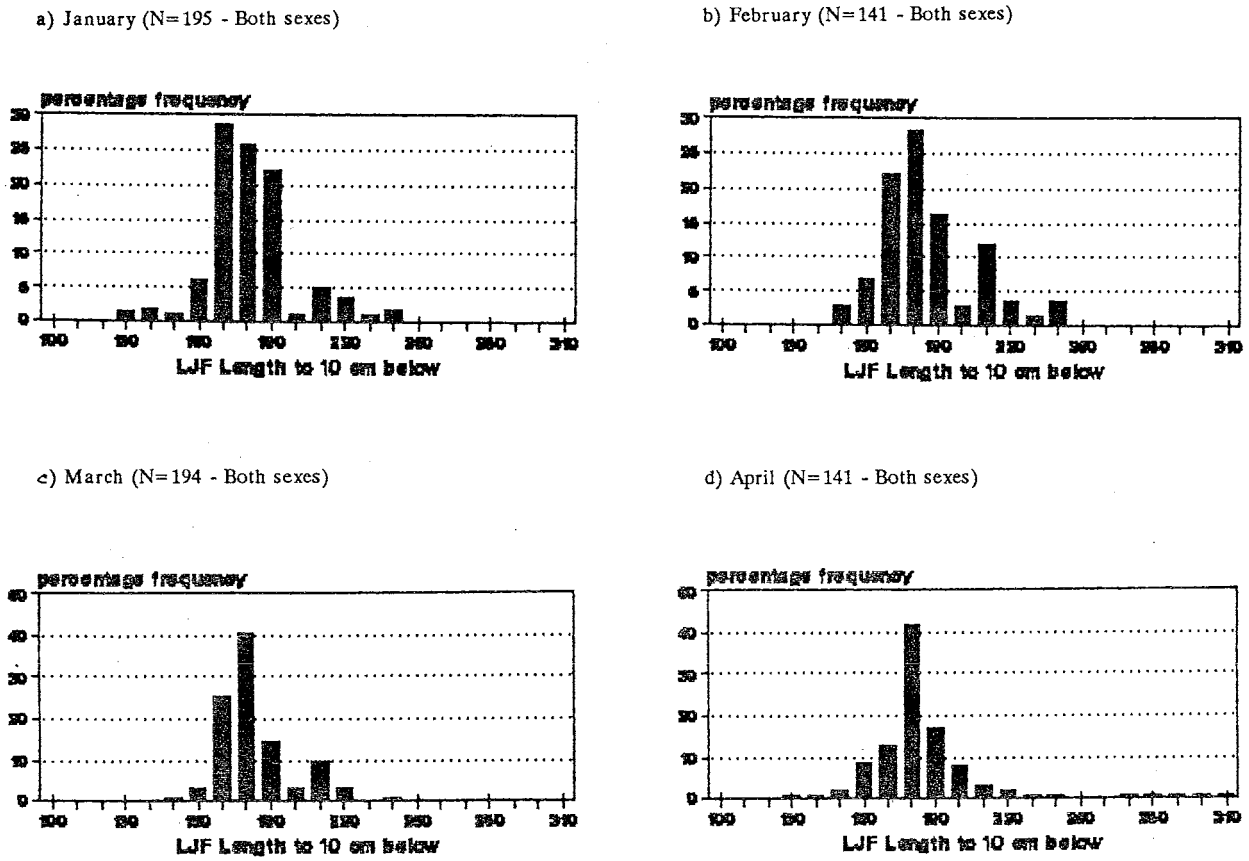
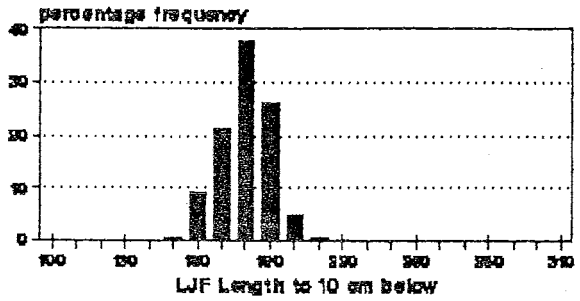
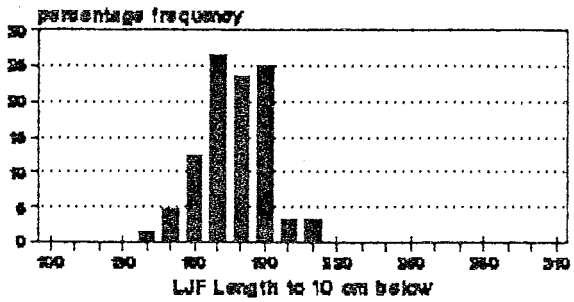


Fig. 9 Monthly length frequencies of sailfish caught by Ghanaian fishery, 1989-1991.

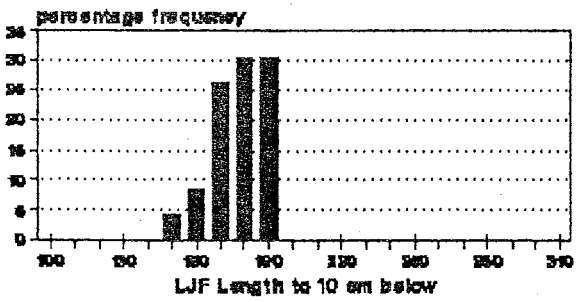
e) May (N=207 - Both sexes)



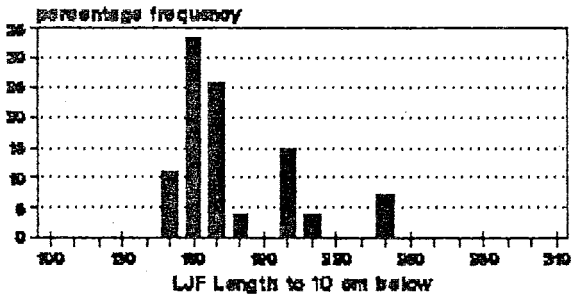
F) June (N=54 - Both sexes)



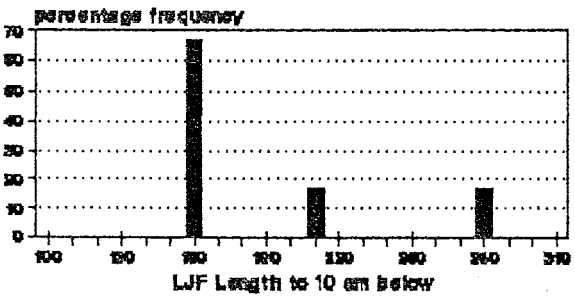
g) July (N=28 - Both sexes)



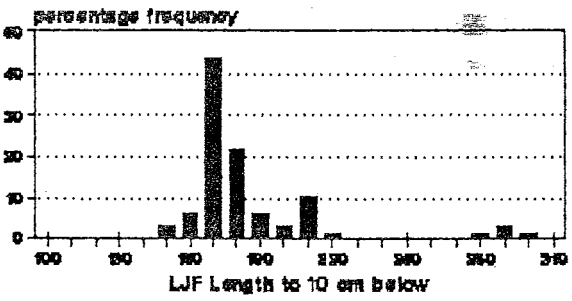
h) August (N=27 - Both sexes)



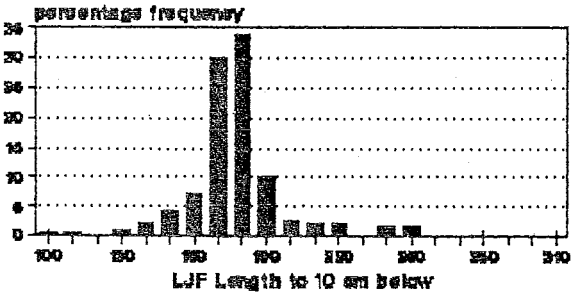
i) September (N=5 - Both sexes)



j) October (N=58 - Both sexes)



k) November (N=250 - Both sexes)



l) December (N=820 - Both sexes)

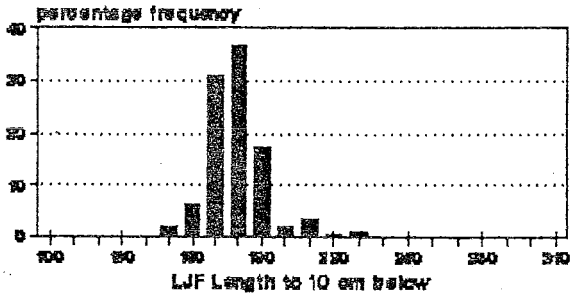
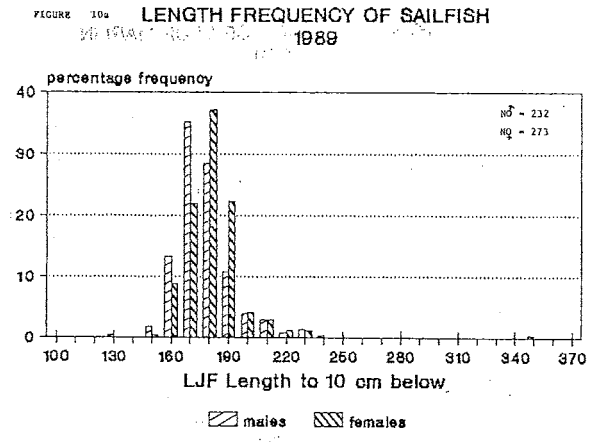
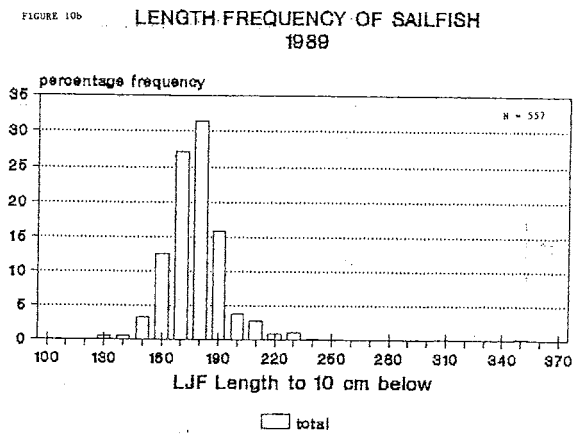


Fig. 9 Continued...

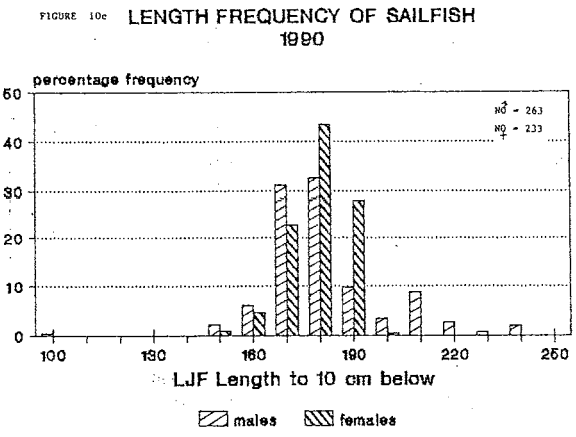
a) By sex - 1989



b) Both sexes combined - 1989

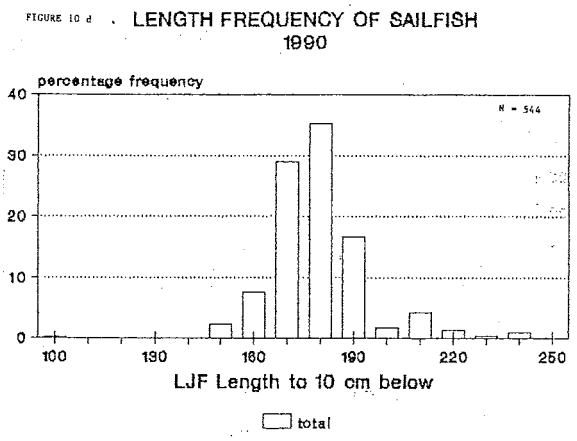


c) By sex - 1990



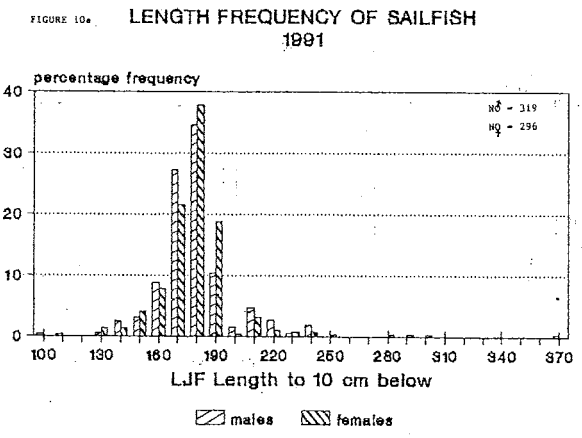
all centres

d) Both sexes combined - 1990



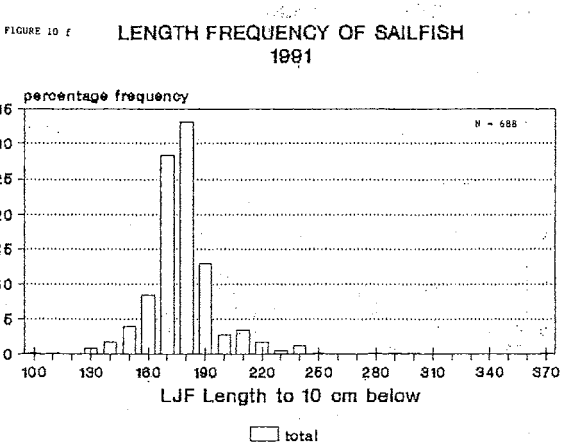
all centres

e) By sex - 1991



all centres

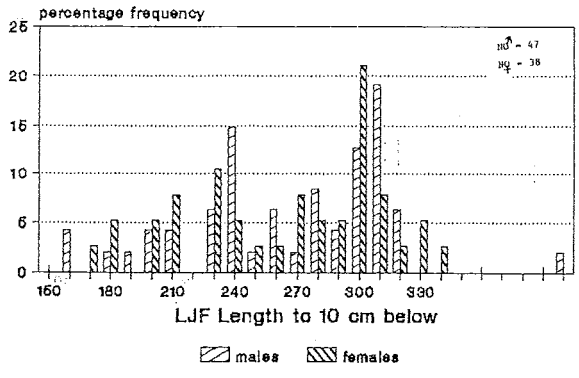
f) Both sexes combined - 1991



all centres

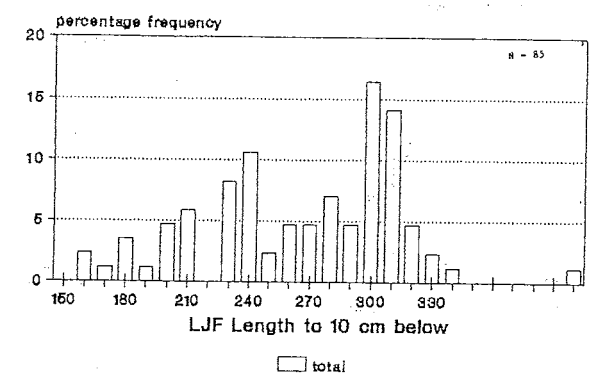
Fig.10 Annual length frequencies of sailfish by sex, caught by Ghanaian fishery, 1989-1991.

a) By sex - 1989



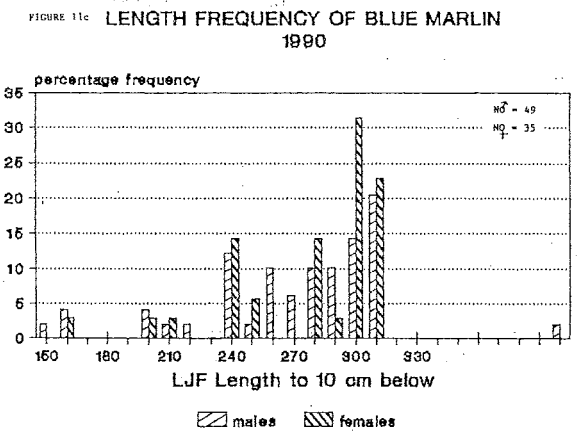
all centres; LJF is lower jaw forklength

b) Both sexes combined - 1989



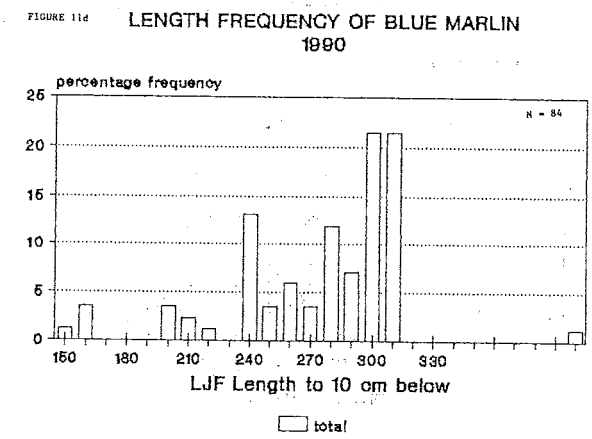
all centres; LJF is lower jaw forklength

c) By sex - 1990



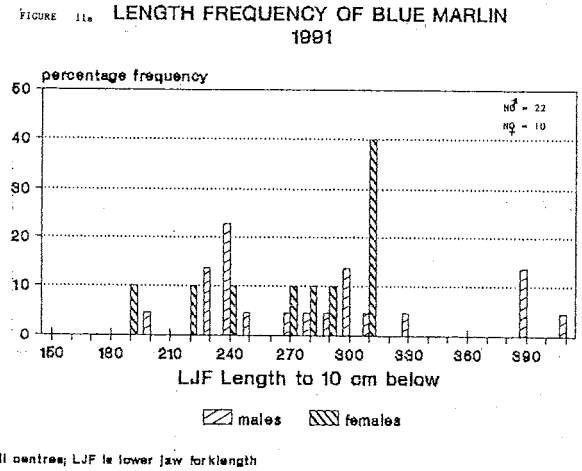
all centres; LJF is lower jaw forklength

d) Both sexes combined - 1990



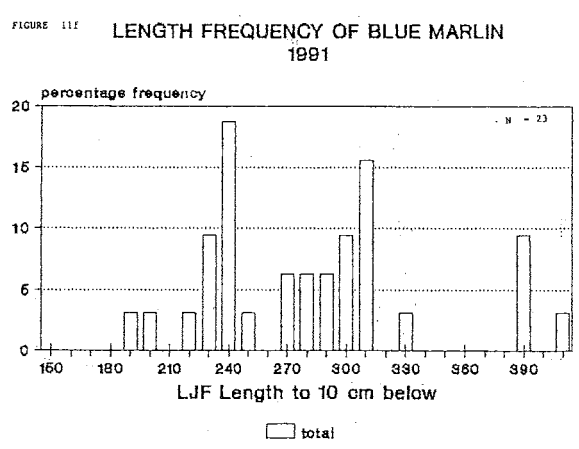
all centres; LJF is lower jaw forklength

e) By sex - 1991



all centres; LJF is lower jaw forklength

f) Both sexes combined - 1991

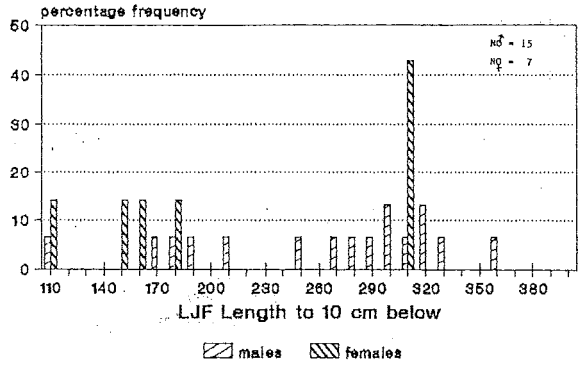


all centres; LJF is lower jaw forklength

Fig.11 Annual length frequencies of blue marlin by sex, caught by Ghanaian fishery, 1989-1991.

a) By sex - 1989

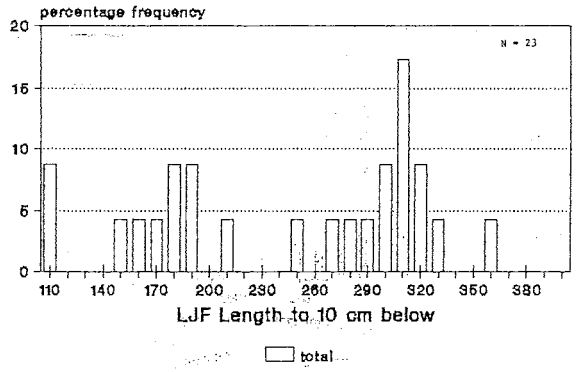
FIGURE 12a LENGTH FREQUENCY OF WHITE MARLIN 1989



all centres; LJF is lower jaw forklength

b) Both sexes combined - 1989

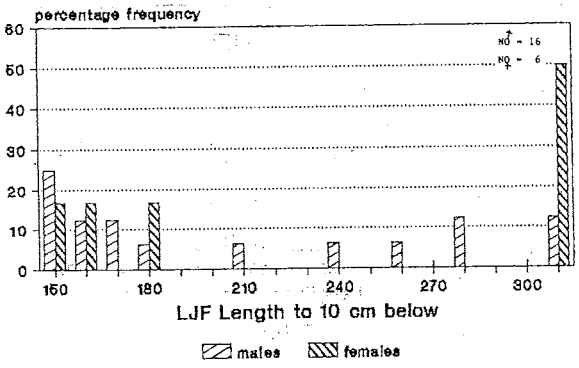
FIGURE 12 b LENGTH FREQUENCY OF WHITE MARLIN 1989



all centres; LJF is lower jaw forklength

c) By sex - 1990

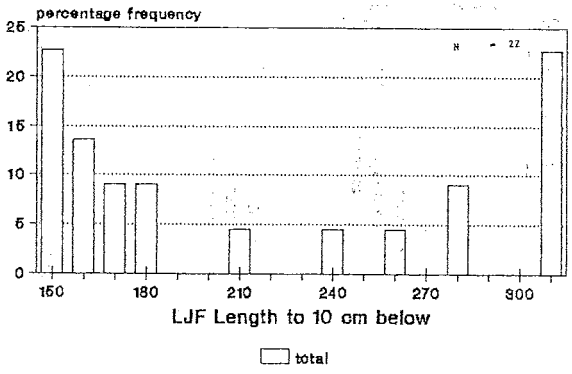
FIGURE 12 c LENGTH FREQUENCY OF WHITE MARLIN 1990



all centres; LJF is lower jaw forklength

d) Both sexes combined - 1990

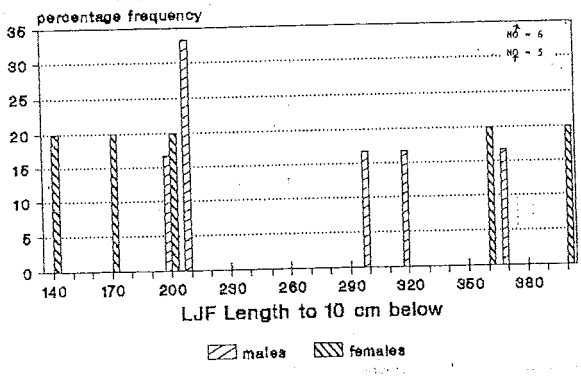
FIGURE 12 d LENGTH FREQUENCY OF WHITE MARLIN 1990



all centres; LJF is lower jaw forklength

e) By sex - 1991

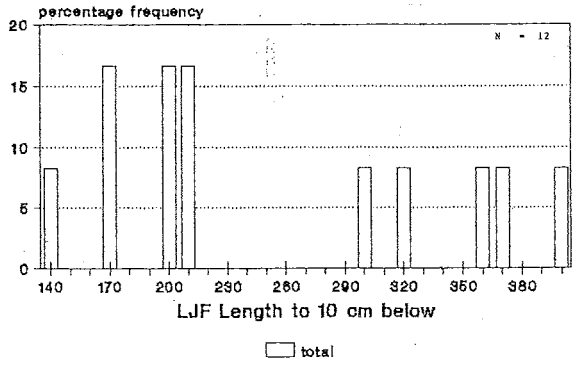
FIGURE 12e LENGTH FREQUENCY OF WHITE MARLIN 1991



all centres; LJF is lower jaw forklength

f) Both sexes combined - 1991

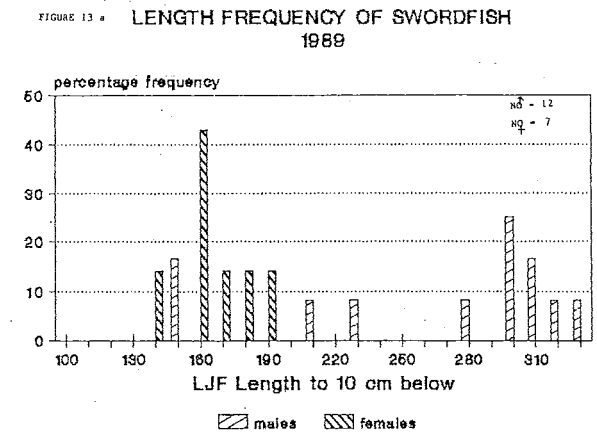
FIGURE 12f LENGTH FREQUENCY OF WHITE MARLIN 1991



all centres; LJF is lower jaw forklength

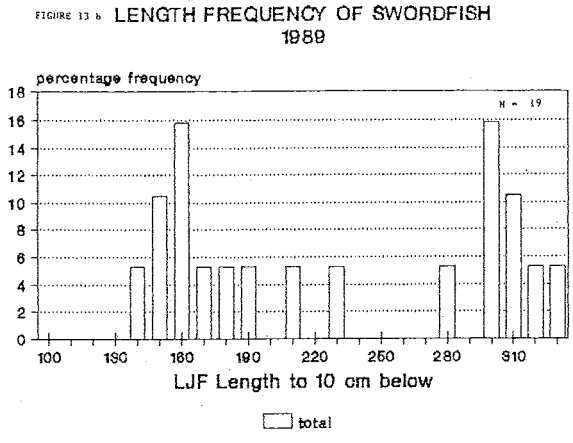
Fig.12 Annual length frequencies of white marlin by sex, caught by Ghanaian fishery, 1989-1991.

a) By sex - 1989



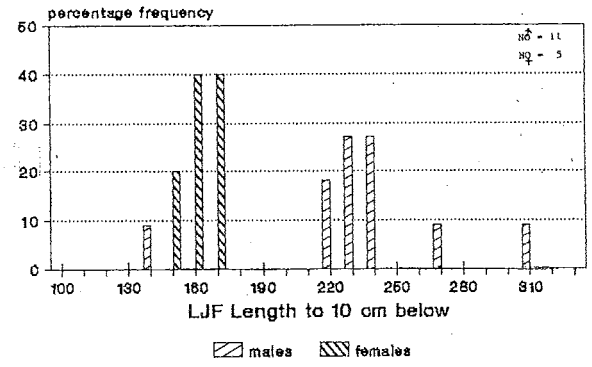
all centres; LJF is lower jaw fork

b) Both sexes combined - 1989



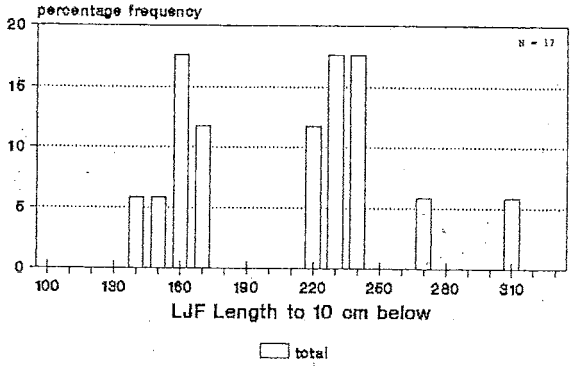
all centres; LJF is lower jaw fork

c) By sex - 1990



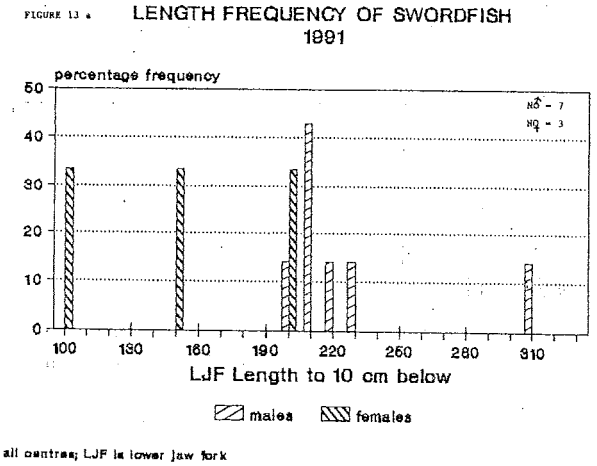
all centres; LJF is lower jaw fork

d) Both sexes combined - 1990



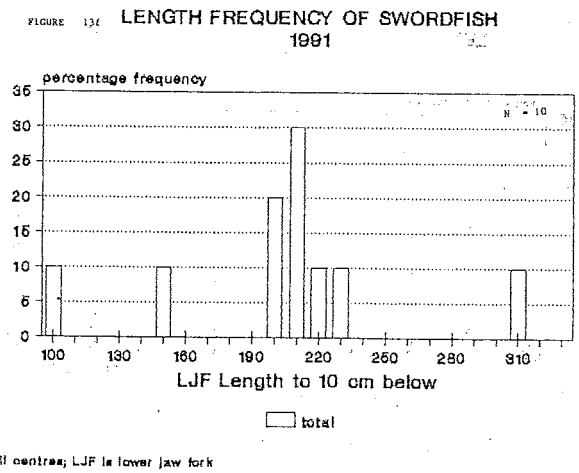
all centres; LJF is lower jaw fork

e) By sex - 1991



all centres; LJF is lower jaw fork

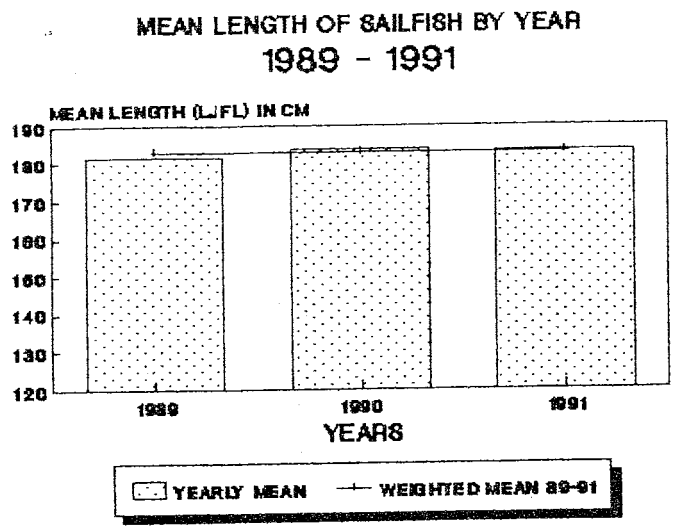
f) Both sexes combined - 1991



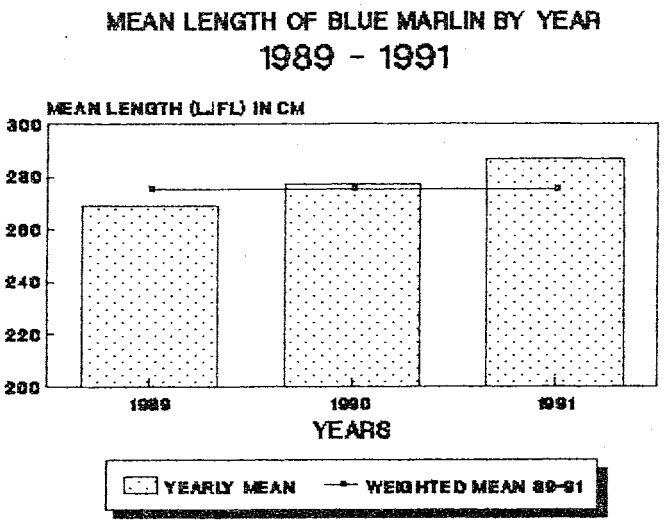
all centres; LJF is lower jaw fork

Fig.13 Annual length frequencies of swordfish by sex, caught by Ghanaian fishery, 1989-1991.

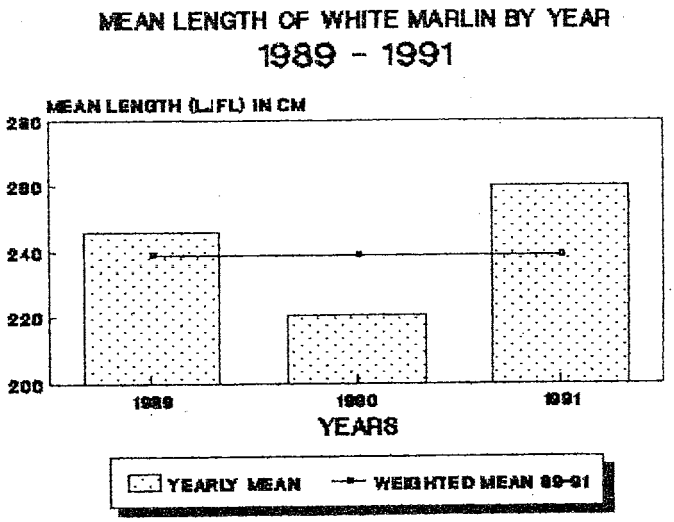
a) Sailfish



b) Blue marlin



c) White marlin



d) Swordfish

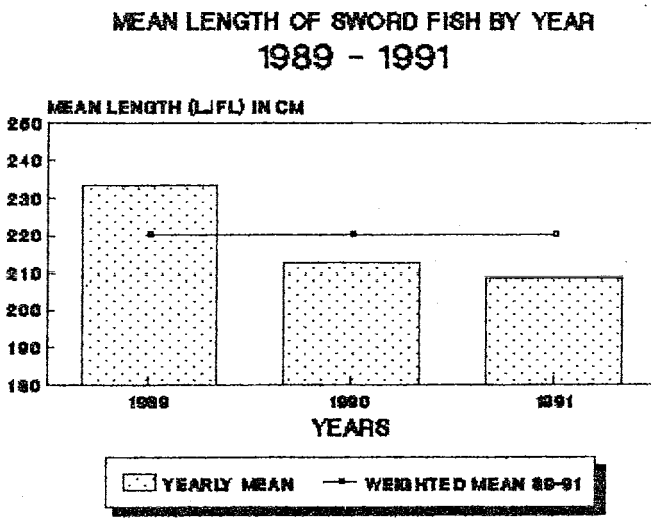


Fig.14 Annual mean of billfishes caught by Ghanaian fishery, 1989-1991.