

**CHANGES IN THE APPARENT ABUNDANCE INDICES OF BILLFISHES
IN THE VENEZUELAN RECREATIONAL FISHERY
OFF PLAYA GRANDE (1961-1990), CENTRAL VENEZUELAN COAST.**

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ABSTRACT

Changes in the apparent abundance of billfishes in the venezuelan sport fishery off Playa Grande Yachting Club are analyzed from 1961 to 1990. Estimates of daily effort and fighting time for each of the main targeted species of this fishery were made in order to calculate an effective fishing time. Confidence intervals for fighting times were obtained by bootstrapping. Sport fishermen in the zone need, in average, about 33 min. to capture a blue marlin, near 20 min. for a white marlin, and about 10 min. for a sailfish. With the use of this standardized effort, the CPUE time series from 1961 to 1989 were drawn. Estimates for 1990 were done by smoothing methods and an auto-regressive model, which finally was preferred. Abundance indices of blue marlin decreased strongly until 1976 (0.01 fish /per man, per trip); a phase of recuperation can be appreciated from this year to 1984, before a slow decrease was observed. Finally, the abundance indices have stabilized around 0.06 fish /per man, per trip during the last five years. In spite of the great inter annual variability, the CPUE of white marlin indicates a constant decrease along the time series. This trend is especially clear for the last ten years, reaching the lowest index of the whole time series during 1989 (0.16 fish /per man, per trip). The analysis of CPUE for sailfish shows three periods: an increase between 1963 to 1969, reaching 1.2 fish /per man, per trip; a regular decrease until 1982 (0.06 fish /per man, per trip), followed by a short increment during the most recent years (0.15 to 0.20). Seasonal indices are also given and compared with other fishing areas. In Venezuela the maximum indices appear relatively spread for blue marlin (winter and spring), and more concentrated for white marlin (July - October) or for the sailfish (September-November, then February).

RESUME

Les modifications de l'abondance apparente des istiophoridés dans la pêche sportive vénézuélienne au large du Yachting Club de Playa Grande sont analysés de 1961 à 1990. Des estimations de l'effort journalier et du temps de pêche de chacune des principales espèces visées par cette pêche ont été effectuées pour calculer un temps de pêche effectif. Des intervalles de confiance ont été calculés par la méthode de "bootstrap" pour le temps de lutte avec le poisson. Les pêcheurs sportifs de cette zone passent en moyenne 33 minutes pour capturer un makaire bleu, près de 20 minutes pour un makaire blanc, et 10 minutes environ pour un voilier. La série temporelle de CPUE de 1961 à 1989 a été établie à partir de cet effort standardisé. Les estimations de 1990 ont été faites par la méthode de lissage et un modèle auto-régressif, qui en fin de compte a été retenu. Les indices d'abondance du makaire bleu ont fortement baissé jusqu'en 1976 (0.01 poissons /pêcheur /sortie); on peut observer une phase de rétablissement de 1976 à 1984, suivie d'une lente décroissance. Enfin, depuis cinq ans, les indices d'abondances se sont stabilisés aux alentours de 0.06 poissons /pêcheur /sortie. En dépit de sa forte variabilité inter-annuelle, la CPUE du makaire blanc indique une baisse constante tout au long de la série temporelle. Cette tendance est particulièrement évidente depuis dix ans, l'indice le plus faible de toute la série

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temporelle ayant été atteint en 1989 (0.16 poissons /pêcheur /sortie). L'analyse de la CPUE du voilier montre trois périodes: un accroissement de 1963 à 1969, atteignant 1.2 poissons /pêcheur /sortie; une décroissance régulière jusqu'en 1982 (0.06 poissons /pêcheur /sortie), suivie d'un bref accroissement les toutes dernières années (0.15 à 0.20). Les indices saisonniers sont également fournis et comparés avec ceux d'autres zones de pêche. Au Venezuela, les indices maximaux semblent relativement répartis pour le makaire bleu (hiver et printemps), et plus concentrés pour le makaire blanc (juillet-octobre) ou pour le voilier (septembre-novembre, puis février).

RESUMEN

Se analizan los cambios en la abundancia aparente de marlines en la pesquería deportiva venezolana frente al Yachting Club de Playa Grande, de 1961 a 1990. Las estimaciones del esfuerzo diario y período de lucha para cada una de las principales especies-objetivo de esta pesquería, se hicieron con el fin de calcular el tiempo de pesca efectiva. Los intervalos de confianza para los períodos de lucha se hicieron por medio del proceso iterativo de reajuste ("bootstrapping"). Los pescadores deportivos de la zona necesitan, por término medio, unos 33 minutos para capturar una aguja azul, cerca de 20 minutos en el caso de la aguja blanca y alrededor de 10 minutos para un pez vela. Las series temporales de CPUE de 1969 a 1981 se establecieron usando este esfuerzo normalizado. Las estimaciones para 1990 se realizaron con métodos de nivelación y con un modelo autoregresivo, que fue el escogido finalmente. Los índices de abundancia de la aguja azul descendieron de forma muy marcada hasta 1976 (0.01 peces /por hombre y por salida); se puede apreciar una fase de recuperación desde dicho año hasta 1984 y después, un lento descenso. Finalmente, los índices de abundancia se han estabilizado alrededor de 0.06 peces /por hombre y por salida, durante los cinco últimos años. A pesar de la gran variabilidad entre años, la CPUE de la aguja blanca muestra un constante descenso a lo largo de la serie temporal. Esta tendencia es particularmente obvia en los últimos diez años, alcanzando el índice mas bajo de toda la serie temporal durante 1989 (0.16 peces /por hombre y por salida). El análisis de la CPUE del pez vela tiene tres períodos: un aumento entre 1963 y 1969, llegando a 1.2 peces /por hombre y por salida, un descenso regular hasta 1982 (0.06 peces /por hombre y por salida) seguido de un escaso incremento en los años mas recientes (0.15 a 0.20). Se dan también los índices estacionales y se comparan con otras zonas de pesca. En Venezuela, los índices máximos parecen estar relativamente repartidos en lo que respecta a la aguja azul (invierno y primavera) y mas concentrados en relación con la aguja blanca (julio-octubre) o con el pez vela (septiembre-noviembre y después febrero).

1. INTRODUCTION.

The billfish sport fishery has a long history in Venezuela, specially at the Playa Grande Yachting Club, which is the most important recreational harbor in the country. This marina is located in the central coast of Venezuela, relatively close (20 Km) to the famous fishing ground known as "Placer of La Guaira". A valuable data base is available today due to the interest in the collection of catch and effort statistics during several years by a former harbor master, Mr. J. ACOSTA.

Indices of abundance for the billfish species caught by this sport fishery - blue marlin (*Makaira nigricans*), white marlin (*Tetrapturus albidus*) and sailfish (*Istiophorus albicans*) - were presented by MACHADO & JAEN (1982), GAERTNER, ALIO & GARCIA DE LOS SALMONES (1989), and GAERTNER, ALIO & AROCHA (1991). Catches of longbill spearfish (*Tetrapturus pfluferi*) are not included because of its scarcity in this fishery (however, this species is relatively frequent in the eastern region of Venezuela, as reported by MARCANO *et al.*, in preparation).

The goal of the present study is to improve the abundance indices obtained in a former analysis (GAERTNER, ALIO & GARCIA DE LOS SALMONES, 1989) and to provide a better understanding about the changes in the apparent abundance of these three species in the southern part of the Caribbean Sea.

The effective effort (Eff) will be:

$$Eff = \frac{(3 * Ef_d * No.Trip) - (Tot.Fight.)}{(3 * Ef_d)}$$

The division by (3 * Ef_d) is made in order to obtain a convenient unit in fishing hours per man per trip.

As mentioned above, fighting time is infrequently reported for several species. Bootstrapping is a good approach to obtain an estimate of the sampling distribution of the mean and variance of the fighting times. The key idea of bootstrapping is to draw a large number of repeated samples of the same size as the original sample, with replacement, from the data (EFRON & TIBSHIRANI, 1986; STINE, 1990). The bth bootstrap sample is denoted: $X^{*(b)} = (X_1^{*(b)}, X_2^{*(b)}, \dots, X_n^{*(b)})$; $X_i^{*(b)}$ is chosen randomly from the original sample. In our case, 1000 bootstraps were made to estimate the mean fighting time, by species, and associated standard deviations. The mean for each of the bootstrap samples: $\bar{X}^{*(b)}$, is:

$$\bar{X}^{*(b)} = N^{-1} * \sum_{i=1}^n X_i^{*(b)}$$

These B bootstrap means $X^{*(1)} \dots X^{*(B)}$, are used to compute the simulated bootstrap variance estimate:

$$Var_B(\bar{X}) = (B-1)^{-1} * \sum_{b=1}^B (\bar{X}^{*(b)} - Avg(\bar{X}^{*(b)}))^2$$

where $Avg(\bar{X}^{*(b)}) = B^{-1} * \sum_{b=1}^B \bar{X}^{*(b)}$ (see STINE, *op. cit.*, p 329).

Bootstrapping also offers an interesting way to compute t-intervals without the requirement of the Gaussian population. Rather than find a percentile from the t table, the goal is to estimate the value $t^*(\alpha, n)$, which is the percentile α of the simulated collection of pivots: $R^* = (X^* - X) / sd_B(X^*)$. It can be observed that this ratio is equivalent to the usual ratio: $(X - \mu) / (s / \sqrt{n})$ which in the case of Gaussian populations is used to determine the confidence interval for μ , following the fact that: $Pr (Pr (\sqrt{n} * (X - \mu) / s \leq t(\alpha, df)) = \alpha$.

A bootstrap procedure with three stages has been built.

- First, B1 bootstrap samples are generated from the collection of individual fighting times (the original samples), where: $X^{*(j)} = (X_1^{*(j)}, \dots, X_n^{*(j)})$, $j = 1, 2, \dots, B1$; next,
- for each of these B1 bootstraps, B2 bootstrap samples are created: $X^{*(jb)} = (X_1^{*(jb)}, \dots, X_n^{*(jb)})$, $b = 1, 2, \dots, B2$ and B2 means calculated ($\bar{X}^{*(jb)}$). This collection of B2 means gives an average mean ($\bar{X}^{*(j)}$) and a bootstrap estimate of the standard deviation $SD_{B2}^{*(j)}(\bar{X}^*)$ of this mean (see STINE, *op. cit.* p.353):

$$SD_{B2}^{*(j)}(\bar{X}^*) = (B2-1)^{-1} * \sum_{b=1}^{B2} (\bar{X}^{*(jb)} - \bar{X}^{*(j)})^2,$$

- then for each B1 sample, the bootstrap pivot $R^{*(j)}$ is formed, as:
 $R^{*(j)} = (\bar{X}^{*(j)} - Avg(\bar{X}^{*(b)})) / SD_{B2}^{*(j)}(\bar{X}^*)$ being the mean of the precedent bootstrap.

Considering the overall cost (time) in calculations of this two stage procedure in order to have an α level of .05, the number of replications was limited to 39 for B1, and to 100 for B2. Indeed, 39 replications

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- then for each B1 sample, the bootstrap pivot $R^{*(j)}$ is formed, as:

$R^{*(j)} = (\overline{X^{*(j)}} - Avg(\overline{X^{*(b)}})) / SD_{B2}^{*(j)}(\overline{X^*})$, with $Avg(\overline{X^{*(b)}})$ being the mean of the precedent bootstrap.

2. THE DATA BASE.

Catch statistics (number of fish) and effort (number of trips), were collected monthly from January 1961 to December 1989. The months of June, July and August of 1964 and 1970, and August 1983 (partially sampled) were adjusted as explained in (GAERTNER, ALIO Y GARCIA DE LOS SALMONES, *op. cit.*). Though it is not possible to discriminate between tournament and non-tournament activities before 1988, the proportion of days with competitions (tournaments) is very low. It is important to point out that this time series was interrupted at the end of the first quarter of 1990 by the prohibition made by the government to landings of billfish in the central part of Venezuela. For this reason, data for 1990 in the present study were estimated by forecasting.

3. DATA ANALYSIS.

3.1 Standardization of the effort.

The abundance index is approximated by the concept of catch per unit of effort (CPUE). For this reason it is more reasonable to use the term "apparent abundance index". In order to optimize this catch rate, the choice of an appropriate unit of effort that most accurately represents the true fishing effort is very important. As in the tuna surface fishery, it is logical to try to eliminate all the time lost in activities other than fishing. BEARDSLEY and CONSER (1981) used the concept of effective fishing time, which corresponds to the number of hours fished minus the fighting time.

Unfortunately the information about this last variable was not collected in the past, and is not always reported today. So we are obliged to use a "statistical estimate", obtained with a restricted number of observations, rather than the actual individual fighting time for each fish.

Two other limitations that were confronted, are:

- (1) information about the number of fish hooked is not available, hence it is not possible to use the concept of number of fish hooked per unit of effort (HPUE), which is considered as a better estimate than the CPUE index (BEARDSLEY & CONSER, *op. cit.*; BROWDER & PRINCE, 1990); and,
- (2) the lack of information about the use of different categories of line-test prevents us from analyzing the effect of this important variable; although the line used in tournaments is usually the same (20 lb.).

Considering these points, the main goal of this study is to standardize the nominal effort to a more effective effort unit. In order to accomplish this task, the following steps were made:

- (a) Estimation of the daily effort ($Ef. d.$) by trip. With the data obtained in recent years, we compare this parameter between tournament and non-tournament days.
- (b) Estimation of the fighting time for the 7 main species ($Spe. Fight.$). This includes the 3 species of *istiophoridae* (BUM, WHM, SAI), tunas (generally yellowfin tuna: *Thunnus albacares*, YFT), wahoo (*Acanthocybium solandri*, WAH), dolphinfish (*Hippurus spp.*, DOR), and barracuda (*Sphyræna barracuda*, PIC). It has been considered that between the strike and the time when the fish is brought on board, the other two fishermen (generally there are three on board) cannot fish. Hence, the estimate of the total time lost during the fighting time ($Tot. Fight.$) will be multiplied by 3, as follows:

$$Tot. Fight. = 3 * \sum_{j=1}^7 (Spe. Fight. j * C_j) \quad \text{with } C_j = \text{No. fish for species } j.$$

Considering the overall cost (time) in calculations of this two stage procedure in order to have an α level of .05, the number of replications was limited to 39 for B1, and to 100 for B2. Indeed, 39 replications for B1 leads to 39 R pivots, dividing the entity into 40 segments; each containing 2.5 % of the total probability.

Hence, to obtain the analogous value $t^*(\alpha, n)$, the R pivots are arranged in order (R_1, R_2, \dots, R_{39}), to find the desired percentiles. The lower and the upper endpoints of the bootstrap interval will be respectively:

$$\text{Avg}(\bar{X}^{*(b)}) + R_{(1)} * SD_B^*(\bar{X}) \quad \text{et} \quad \text{Avg}(\bar{X}^{*(b)}) + R_{(39)} * SD_B^*(\bar{X})$$

3.2 Estimates for 1990.

With the "best" effective effort that we could obtain, we then attempted to estimate the effort and CPUE values for 1990. Forecasting can be made with different approaches, from the simple smoothing methods, to the more sophisticated BOX-JENKINS model, combining auto-regressive (AR) and moving average (MA) terms.

The main goal of the smoothing methods is to give a greater weight to the most recent observed values of the time series. The parameters of the forecasting function depend on the "history" of the time series. For instance, for the "Simple Exponential Smoothing" the forecast value at time $(t+1)$ will be:

$$Y_{(t+1)} = \beta(Y_{(t)} + (1-\beta)Y_{(t-1)} + (1-\beta)^2Y_{(t-2)} + \dots)$$

or

$$Y_{(t+1)} = \sum W_j * Y_{(t-j)} ; \quad j=0,1,\dots$$

where $W_j = \beta * (1-\beta)^j$ and $\sum W_j = 1$; in COUTROT & DROESBEKE (1984).

For the two exponential smoothing techniques (Simple and Generalized), the smoothing factor (β) is optimized to obtain the lower residual sum of square (RSS), as:

$$RSS(\beta) = \sum (Y_{(t)} - \hat{Y}_{(t)})^2$$

A good description of the effectiveness of auto-regressive and moving average models (ARIMA) in fisheries is given by SAILA, WIGBOUT & LERMIT (1980), and MENDELSSOHN (1980). In the present study, we used only the AR option of these models which can be represented as:

$$Y_{(t)} = \Phi_1 Y_{(t-1)} + \Phi_2 Y_{(t-2)} + \dots + \Phi_p Y_{(t-p)} + \epsilon_{(t)}$$

where Φ represents the backshift operators.

The first step in this kind of analysis consists in removing deterministic trends by transformation and (or) differencing to obtain a stationary series (JEFFRIES, KELLER and HALE; 1989).

In order to stabilize the variances of the time series, we have used the logarithmic transformation. The next step is to examine the autocorrelation (ACF) and partial autocorrelation (PACF) functions, and to difference, if necessary, the transformed time series. Smoothing methods and AR are calculated with the help of the STAT-ITCF³ package.

In order to check these models, yearly data from 1961 to 1988 were used to forecast the already observed CPUEs and effort for 1989. The "best fit" model was used to forecast 1990.

³ ITCF= Institut Technique des Céréales et des Fourrages (Paris)

4. RESULTS

4.1 Daily effort and fighting time.

The mean daily effort during tournaments is greater than the same parameter in non-tournaments (7H 03' vs. 6H 15'; Tab. 1). Due to the fact that the distribution of the daily effort for non-tournament trips is skewed (Fig. 1), we use the Kolmogorov-Smirnov (two samples test) to compare the two distributions. The $D(\max) = .2719$ implied that the two distributions differ significantly ($P < 0.01$). Unfortunately, we do not have the number of tournaments per year, and the number of participants per event, before 1988. Therefore we cannot correct the data base with this result. Nevertheless, if we consider that in the past this proportion was roughly the same as the actual one (6 to 7 tournaments per year, with a general duration of two days each of them), the bias does not seem to be very important.

The distribution of the individual fighting time, and the bootstrap distribution of the mean fighting time by species, are shown in figures 2 a,b,c. These results indicate that fishermen need, on the average, a little more than thirty minutes to capture a blue marlin (once the strike occurs), twenty minutes for a white marlin, and so on (Tab. 2). It must be emphasized that the size of the animals is not considered in this study. For instance, for a given species, it is logical to think that the fighting time to capture a big fish will be longer than the time spent with a juvenile. So, these estimates must be limited to the central part of Venezuela, where the size distribution of the Istiophoridae is better known (at least in the recent years, with the hypothesis that it was approximately the same in the past). The size range of billfishes (LJFL in cm) captured in the recreational fishery off Playa Grande were, roughly:

- 180 cm & 210 cm for BUM;
- 150 cm & 175 cm for WHM;
- 165 cm & 180 cm for SAI, (GAERTNER, ALIO & AROCHA, *op. cit.*).

On the other hand, it will be hazardous to extrapolate these estimates to other places. It is known for instance that blue marlin landed at marinas of Puerto La Cruz reach larger sizes than in the Central part of Venezuela (see Fig. 9, from the same authors); hence fighting times must also be greater.

The application of bootstrapping can provide consistent results, in spite of the low number of samples and the existence of outliers in some cases, thus percentiles can be generated to give confidence intervals (Tab. 2).

4.2 Estimates for 1990.

The estimated ACF and PACF for the transformed series are given in Table 3. A first-order difference is suggested in order to achieve the stationary condition. The ACF of the residuals for the transformed and first differenced series do not show the usefulness of further differencings (Tab. 4). Parameter estimates and associated statistics for the AR models are presented in Table 5.

In general, smoothing methods do not fit very well time series with a strong yearly variability. This is the case at the beginning of the CPUE series of blue marlin (Fig. 3a) and of sailfish (Fig. 3b), or over all the series for the abundance index of white marlin (Fig. 3b), whose fluctuations are substantial. When the series are less perturbed (for instance, the effort series or the series for the two first species in the middle and at the end of the time series), smoothing methods give a better fit. However, the AR model fits better, but, like the other two models, it also presents a little delay of adaptation following a sudden change in the observed series.

The comparison between the observed values in 1989 and the results of the three forecasting models also indicates that, in general, the AR model prediction is better (Tab. 6), in spite that the results of these models are very close. In this study, the interest to use the AR model to forecast the data in 1990, is more associated to the fact that it can produce confidence limits, than to the gain in fit. The global yearly time series, with the estimates for 1990 using the AR model is presented in table 7.

4.3 Changes in apparent abundance indices.

The CPUE of blue marlin decreased strongly from 1962 (.25 fish per boat per man) to 1976 (year with the lowest indice: .01). Progressively, the CPUE climbed until .14 in 1984, before it stabilized around .05 in the five most recent years (fig 3b). This small increase of apparent abundance could also be observed in the U.S. recreational index between 1978 and 1984 (BROWDER & PRINCE, 1990), in the Jamaican sport fishing activities between 81 and 86 (HARVEY, 1990), and finally, but more recently (86-89), in the U.S. Virgin Islands (FRIEDLANDER, 1991).

Abundance indices of white marlin showed a decreasing trend along the time series but with a very high inter annual variability (at least during the first twenty years of this series). "Bad" years, as 1963, 1969, 1974, 1978, alternate with "good" years, as 1964, 1971, 1975 or 1980 (Fig 3c). In the other hand, during the last ten years the variability has been low but with a steady decline of CPUE, reaching in 1989 the same low level as in 1978 (.16 and .18). This last trend is also reported by BROWDER & PRINCE, *op. cit.*, between 1980 and 1986.

The CPUE of sailfish increased between 1963 and 1969 (the maximum value of the series: 1.2) and decreased strongly until 1982 (.06). This series, after a little recuperation, has stayed at a low level (.15 to .20) during the recent years (Fig 3d).

4.4 Seasonality.

The seasonal indices are represented in Fig. 4. For white marlin the best season occurs between July and October with low values during March - June. The situation is different for blue marlin which has its maximum abundance between November to June and low values in July-September. With the exception of February, the higher values of CPUE for sailfish are observed in the second part of the year, mainly during September-November.

The pattern of seasonality observed for white marlin in the central part of Venezuela is similar to that observed in the northern Gulf of Mexico (BROWDER & PRINCE, *op. cit.*; BEARDSLEY & CONSER, 1981). MATHER, CLARK & MASON (1975) considered that this species feeds in these two areas, before returning to the Great Antilles, Bahamas or Florida to spawn in spring.

GUITARD, JUAREZ & MILERA (1981, in ESPINOSA et. al., 1988) proposed that the spawning of this species occurs near Cuba, and found that the best CPUE for longliners spread from April to June (UEYANAGI et. al., 1970; WISE & DAVIS, 1973; OLAECHEA et. al., 1988). For the same gear highest indices appear between December and March in the lesser Antilles (WISE & DAVIS, *op. cit.*) or in November - December in Venezuela (GONZALEZ & GAERTNER, 1991). Up to this moment no mature individuals of white marlin have been observed in the venezuelan sport fishery (JAEN, 1960; GARCIA DE LOS SALMONES, INFANTE & ALIO, 1989). In the other hand, gonads relatively well developed (stage III) were described in 7 males (no females have been sampled) in the sport fishery off Cozumel island (Mexico), during March - May (GONZALEZ, 1992).

The seasonal indices of blue marlin in the southern part of the Caribbean Sea are totally opposed to what occurs in the other fishing grounds of this species in the West Atlantic Ocean: Gulf of Mexico (BROWDER & PRINCE, *op. cit.*; RIVAS (1975); Great Antilles (WISE & DAVIS, *op. cit.*; OLAECHEA et. al., *op. cit.*), and near the U.S. Virgin Islands (HUNTE, 1985), where the fishing season spreads between June to October. Nevertheless, it is interesting to point out that in contrast to the situation observed in the sport fishery off Playa Grande, the preliminary study on the CPUE of venezuelan longliners targeting swordfish (*Xiphias gladius*) by GONZALEZ & GAERTNER (1991), seems to indicate that higher CPUE of blue marlin are in August.

The area adjacent to the Great Antilles is known to be a sector of spawning in summer for blue marlin (ERDMAN, 1968; GUITARD, JUAREZ & MILERA, *op. cit.*). It is also possible that blue marlin reproduces near the East coast of the Yucatan Peninsula where gonads of 2 fishes (male and female) have been observed in stage IV during March-May (GONZALEZ, 1992). In the samples obtained in the venezuelan sport fishery, JAEN (*op. cit.*) and GARCIA de los SALMONES., INFANTE & ALIO (*op. cit.*) indicated that no females but several males were observed with developed gonads.

The period with maximum landings of sailfish made in Grenada or in the U.S. Virgin Islands, November to April and November to February, respectively (HUNTE, op. cit.), can be compared with best seasonal indices in Venezuela. In the northern Gulf of Mexico the fishing season occurs earlier in the year: April-September for the longline fishery (WISE & DAVIS, op. cit.) and June-September for the sport fishery (BEARDSLEY & CONSER, op. cit.). Near Cozumel Island, the fishing season is between March to May (sailfish constitute near 90 % of the catch of billfish; MARTINEZ, 1992). According to BEARDSLEY, MERRETT & RICHARDS (1975), the spawning season occurs from April to September. Several fishes sampled in March-May, near Cozumel Island by GONZALEZ (op. cit.) were in stage III of maturation. In Venezuela, sailfish in reproductive condition have been observed in February-May and in August-November (GARCIA de los S, INFANTE & ALIO, op. cit.).

5. ACKNOWLEDGMENTS.

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Table 1. Daily effort (Ef. d.), in decimal values, and confidence-intervals (at 5% level) in relation with the categories of sport fishing - activities.

Category	Daily Effort	Variance	No. observ.	C.I. Sup.	C.I. Inf.
Tournament	7.046 (7H 02'45")	1.076	105	7.244 (7H 14'38")	6.848 (6H 50'53")
Non-Tourn	6.249 (6H 14'46")	5.517	747	6.418 (6H 25'03")	6.080 (6H 04'50")

Table 2. Bootstrap estimations (1000 samples) of fighting time (Spe. Fight.) for the main species caught by sport fishermen in Venezuela. "n" represents the size of the original sample; Confidences Intervals (C.I.) are also obtained by bootstrapping (see text).

Species	Fighting time	Variance	C.V.	n	C.I. sup.	C.I. inf.
BUM	0.5437 (32'37")	0.0070	15.376	19	0.286 (17'10")	0.678 (40'41")
WHM	0.3431 (20'35")	0.0070	24.438	19	0.225 (13'30")	0.534 (32'02")
SAI	0.1759 (10'33")	0.0010	18.375	66	0.047 (2'49")	0.236 (14'10")
DOR	0.0729 (4'22")	.000+	9.441	120	0.048 (2'53")	0.086 (5'10")
WAH	0.0538 (3'14")	.000+	7.269	133	0.041 (2'28")	0.063 (3'47")
YFT	0.2122 (12'44")	0.0047	32.330	46	0.000 (0'00")	0.304 (18'14")
PIC	0.0414 (2'29")	0.0001	25.711	7	0.011 (0'40")	0.071 (4'16")

Table 3. Autocorrelation (ACF) and partial autocorrelation (PACF) functions for the transformed (logaritmie) series (1961-1989).

Item	LAG	1	2	3	4	5	6	7	8	9	10
Effort	ACF	0.82	0.66	0.50	0.32	0.16	0.05	-0.05	-0.07	-0.08	-0.05
	SE	0.19	0.28	0.34	0.37	0.38	0.38	0.38	0.38	0.38	0.38
	PACF	0.82	-0.03	-0.10	-0.16	-0.07	0.02	-0.07	0.12	0.00	0.07
WHM	ACF	0.40	0.18	0.05	0.12	0.06	-0.07	-0.02	0.13	0.30	0.23
	SE	0.19	0.21	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.25
	PACF	0.40	0.02	-0.03	0.12	-0.03	-0.12	0.07	0.16	0.22	0.05
BUM	ACF	0.69	0.50	0.40	0.30	0.18	-0.01	-0.12	-0.21	-0.29	0.28
	SE	0.19	0.26	0.30	0.32	0.33	0.33	0.33	0.34	0.34	0.35
	PACF	0.69	0.03	0.09	-0.02	-0.09	-0.23	-0.08	-0.10	-0.09	0.06
SAI	ACF	0.68	0.60	0.50	0.43	0.38	0.18	0.12	0.01	-0.12	-0.14
	SE	0.19	0.26	0.31	0.34	0.36	0.37	0.38	0.38	0.38	0.38
	PACF	0.68	0.21	0.08	0.04	0.03	-0.28	-0.03	-0.12	-0.18	0.05

Table 4. Autocorrelation functions (ACF) for the transformed (logarithmic) and 1st differenced series (1961-1989).

Item	LAG	1	2	3	4	5	6	7
Effort	ACF	-0.32	0.05	0.08	-0.10	0.01	0.06	-0.20
	SE	0.19	0.21	0.22	0.22	0.22	0.22	0.22
WHM	ACF	-0.32	-0.08	-0.24	0.19	0.07	-0.17	-0.07
	SE	0.19	0.21	0.22	0.23	0.23	0.23	0.24
BUM	ACF	-0.22	-0.09	0.04	0.02	0.01	-0.09	-0.05
	SE	0.19	0.20	0.21	0.21	0.21	0.21	0.21
SAI	ACF	-0.37	0.06	-0.10	0.01	0.17	-0.21	0.03
	SE	0.19	0.21	0.22	0.22	0.22	0.23	0.24

Table 5. Parameters estimates and associated statistics for auto-regressive model: $Y(t) = \Phi * Y(t-1) + E(t)$, for transformed (logarithmic) and 1st differenced yearly data (1961-1989).

Variables	Φ	S.E.	Pred. Val. 1990	S.E.	Pred. Val. 1990 Low. Lim.	Up. Lim.
EFFORT	-0.2722	0.1818	7.0474	0.1544	6.7440	7.3501
WHM	-0.3152	0.1794	-1.6970	0.6837	-3.0370	-0.3570
BUM	-0.2504	0.1830	-2.8603	0.5580	-3.9539	-1.7667
SAI	-0.3742	0.1752	-1.8783	0.5375	-2.9318	-0.8248

Table 6. Comparison of the observed effort and catches in 1989 and the predicted values estimated by the three forecasting methods (1961-1988): Simple Exponential Smoothing (SES), Generalized Exponential Smoothing (GES) and Auto-regressive model (AR); for the AR model confidence intervals are given at 5% level (data are retransformed at the original scale).

Item	Observed	SES	GES	AR	CI AR (Low.)	CI AR (Upp.)
EFFORT	1119.84	1234.16	1312.16	1241.03	916.63	1680.25
WHM	0.16	0.25	0.30	0.24	0.06	0.95
BUM	0.07	0.04	0.06	0.04	0.01	0.13
SAI	0.20	0.10	0.13	0.13	0.04	0.37

Table 7. Yearly effort (No. trips standardized in effective fishing time) and yearly CPUE (No. fishes / effective effort) for white marlin, blue marlin and sailfish at Playa Grande Yachting Club. Estimates for 1990 were obtained with the Auto-regressive model. Lower and Upper bounds are given at a 5 % level.

YEARS	EFFORT	WHM	BUM	SAI
61	600.0	1.202	0.170	0.478
62	404.8	0.830	0.254	0.464
63	436.6	0.614	0.112	0.163
64	490.7	1.278	0.087	0.371
65	475.1	1.187	0.065	0.261
66	582.3	0.927	0.187	0.805
67	720.6	1.156	0.129	0.587
68	790.7	0.649	0.120	0.564
69	766.1	0.299	0.137	1.196
70	818.6	0.498	0.123	0.612
71	915.1	2.439	0.066	0.520
72	1048.2	0.803	0.032	0.392
73	712.9	1.401	0.024	0.285
74	699.5	0.359	0.047	0.422
75	677.1	1.351	0.018	0.245
76	692.7	0.858	0.012	0.271
77	758.3	0.359	0.021	0.132
78	964.8	0.175	0.020	0.084
79	639.1	0.390	0.047	0.128
80	879.1	1.156	0.043	0.148
81	914.4	0.693	0.068	0.096
82	906.4	0.749	0.032	0.056
83	1189.3	0.646	0.073	0.153
84	1161.6	0.445	0.141	0.262
85	1286.4	0.451	0.061	0.217
86	1170.6	0.211	0.054	0.128
87	1258.4	0.234	0.064	0.210
88	1234.2	0.250	0.037	0.100
89	1119.8	0.159	0.066	0.196
Est. 90	1149.9	0.183	0.057	0.153
Low. b.	849.5	0.048	0.019	0.053
Upp. b.	1556.2	0.700	0.171	0.438

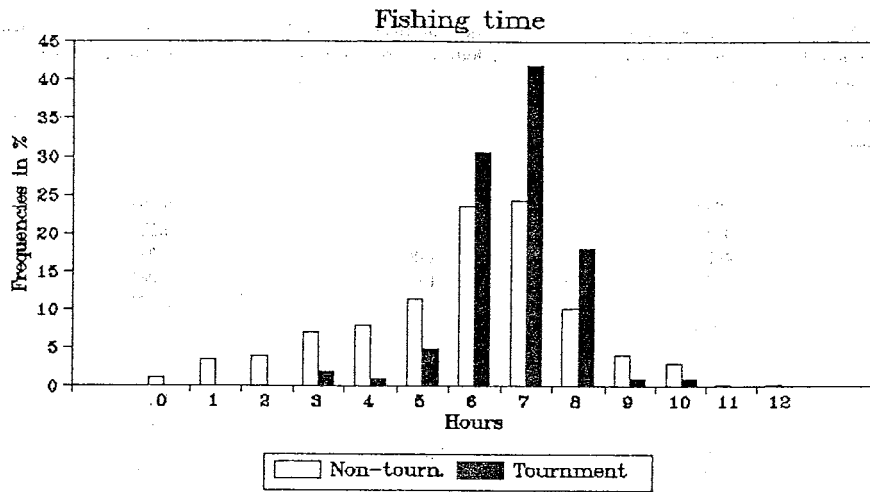


Fig. 1 Individual daily effort ($Ef. d.$) for tournament and non-tournament activities for sportfishermen at Playa Grande Yachting Club axes is divided in 0-1h, 1-2h, etc.

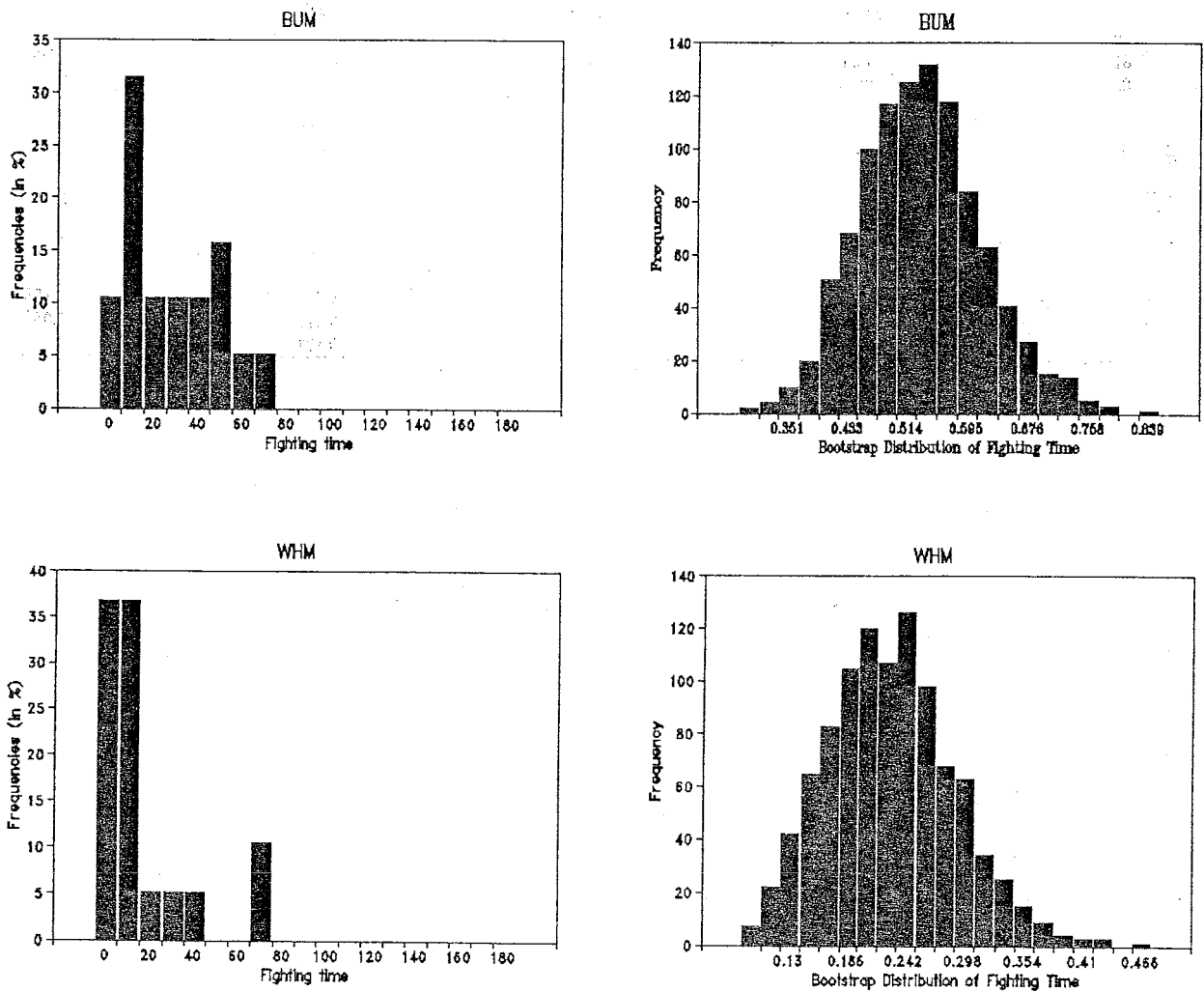


Fig. 2 Frequency distribution for individual fighting time ($Spe. Fight.$): 0 - 10', 10 - 20', etc, from original samples in the left, and bootstrap distribution for mean fighting time (1000 samples), in the right part.

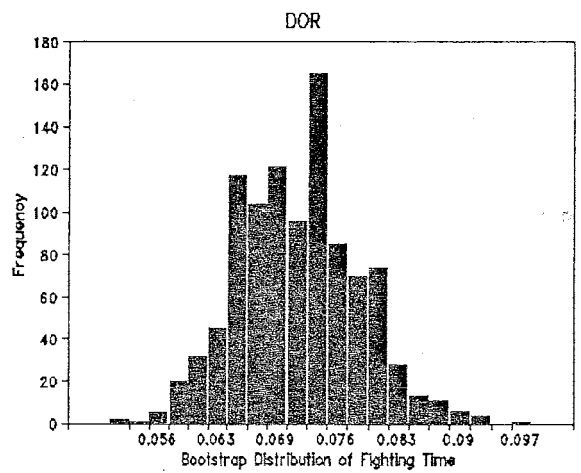
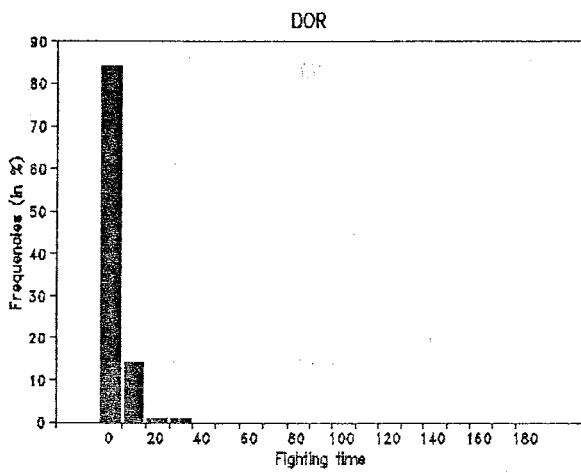
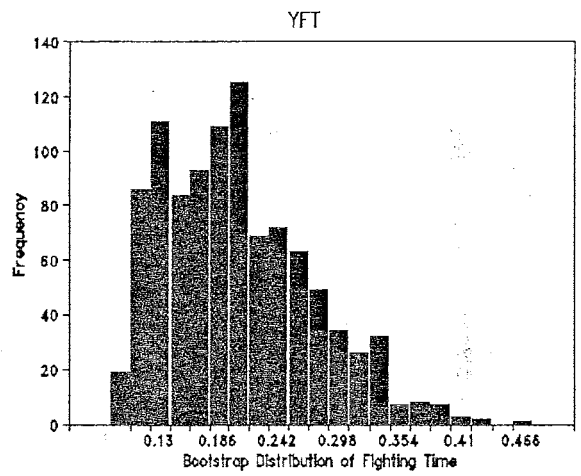
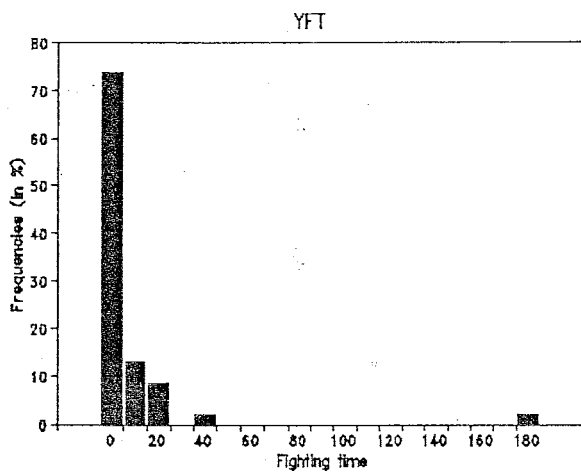
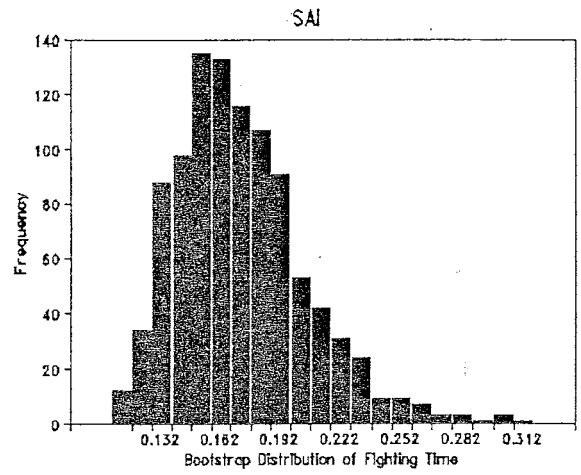
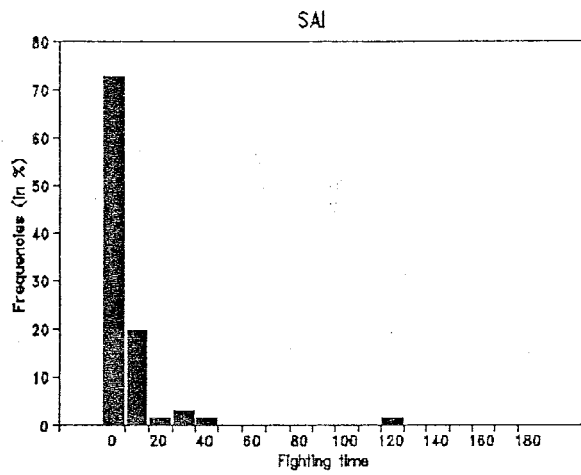


Fig. 2 Continued..

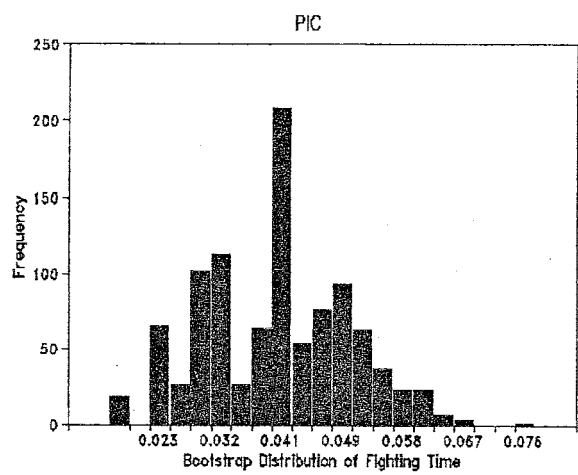
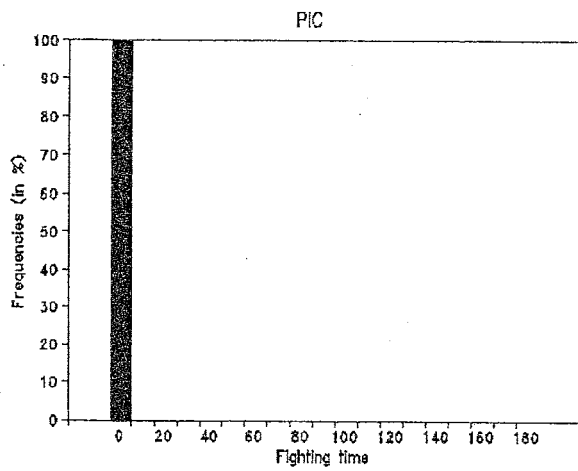
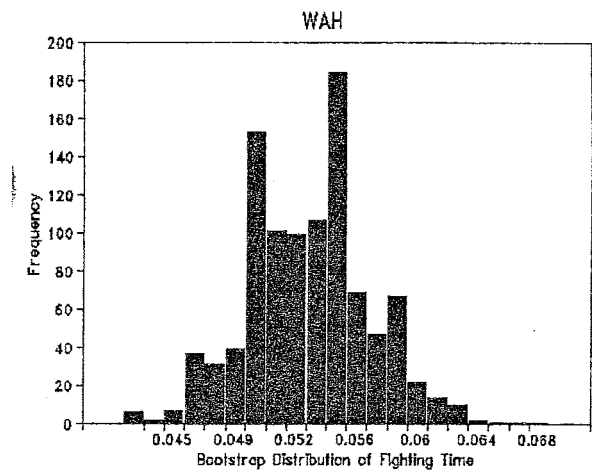
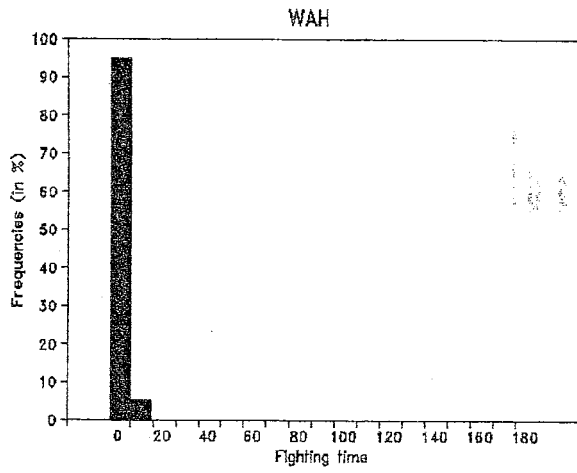


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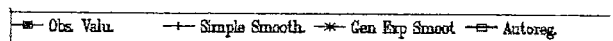
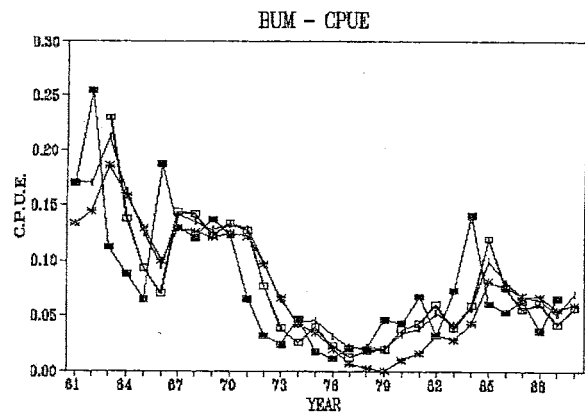
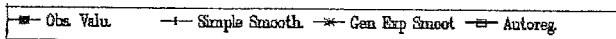
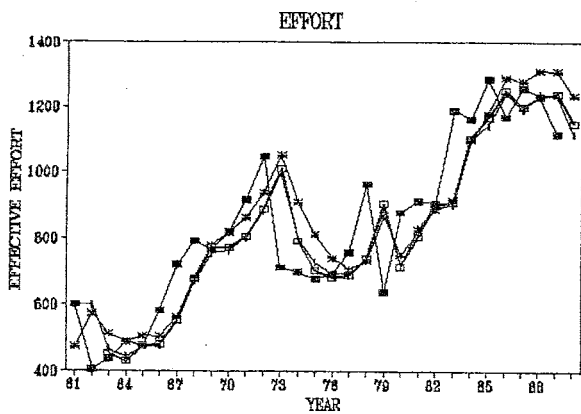
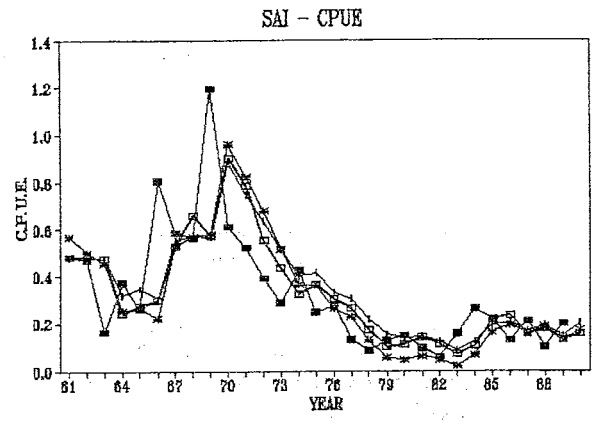
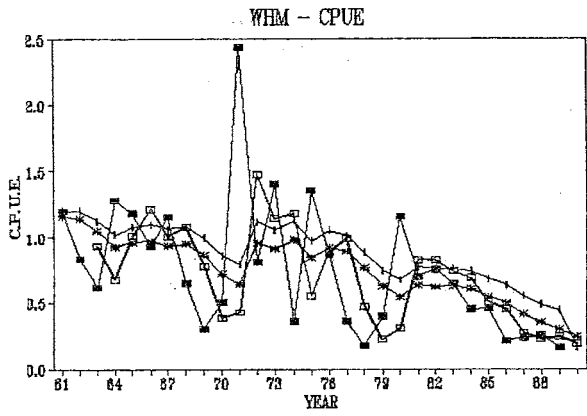


Fig. 3 Comparison between Simple Exponential Smoothing, Generalized Exponential Smoothing and auto-regressive fits.



■ Obs. Value - - - Simple Smooth * - * Gen Exp Smoot □ Autoreg

■ Obs. Valu. - - - Simple Smooth * - * Gen Exp Smoot □ Autoreg

Fig. 3 Continued..

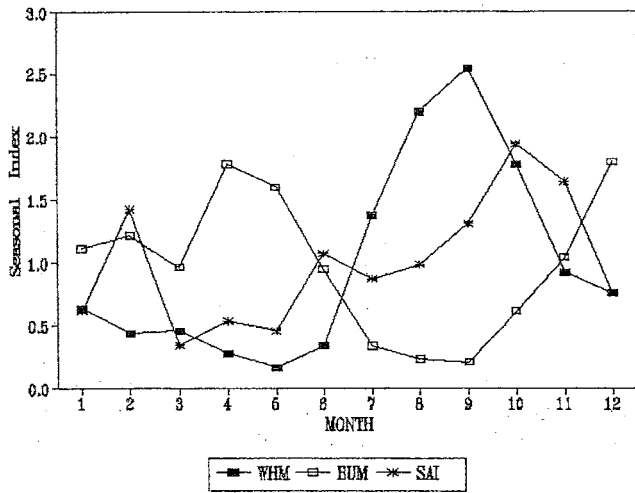


Fig. 4.- Seasonal indices of abundance at Playa Grande Yachting Club for white marlin, blue marlin and sailfish.