ANALYSIS OF THE SANTOS FLEET FROM SÃO PAULO, SOUTHERN BRAZIL (1971-1999)

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SUMMARY

Blue marlin (Makaira nigricans), *white marlin* (Tetrapturus albidus), *and sailfish* (Istiophorus platypterus) *are caught off the south and southeast Brazilian coasts by Brazilian and leased (Honduras and Barbados flags) longliners of Santos city, São Paulo State, Brazil. This paper reports statistics for the Santos fleet including blue marlin, white marlin and sailfish annual yield for 1971-99, monthly yield for 1995-97, annual CPUE for 1995-99, and average weight of white marlin for 1992-95. White marlin annual yield showed an increasing trend from 1971 to 1991, followed by a gradual decline until 1999. The annual average dressed weight of white marlin showed a decrease from 24.0-27.7 kg in the 1971-84 period, to 18.6 kg in 1995. Blue marlin was much more susceptible to the shallow longline gear than it was to the regular longline, showing a large increase in yield and CPUE from 1995 to 1999, mainly between January and March (Summer). A comparison of the three fleets showed that Brazilian longliners had the highest CPUE for white marlin and sailfish. For blue marlin, the greatest values of CPUE corresponded to Brazilian longliners in 1995, Barbados longliners in 1996 and 1998, and Honduras longliners in 1997. Sailfish yields presented a dramatic decline from 1976 to 1999 and the highest sailfish catches occurred in December and January. The length/weight relationships obtained were, for white marlin:* $Wt = 1.05 \times 10^{-5} LJFL^{2.89}$, *for blue marlin:* $Wt = 9.07 \times 10^{-7} LJFL^{3.44}$, *and for sailfish:* $Wt = 4.95 \times 10^{-6} LJFL^{2.99}$. *Information about Brazilian sport fisheries is also presented.*

RESUMEN

La aguja azul (Makaira nigricans), *la aguja blanca* (Tetrapturus albidus) *y el pez vela* (Istiophous platypterus) *se pescan frente a las costas sur y sudeste de Brasil, con palangreros brasileños y alquilados (con banderas de Honduras y Barbados) de la ciudad de Santos, Estado de Sao Paulo (Brasil). Este documento presenta estadísticas de la flota de Santos, incluyendo la producción anual de aguja azul, aguja blanca y pez vela en 1971-99, producción mensual de 1995-97, CPUE anual de 1995-99 y peso medio de la aguja blanca de 1992-95. La producción anual de la aguja blanca mostraba una tendencia al aumento entre 1971 y 1991, seguido de un descenso paulatino hasta 1999. El peso medio anual eviscerado de la aguja blanca presentaba un descenso, desde 24,0-27,7 kg en el período 1971-84, hasta 18,6 kg en 1995. La aguja azul era mucho más accesible al palangre de superficie que al palangre regular, presentando un gran incremento en la producción y CPUE de 1995 a 1999, sobre todo entre los meses de enero y marzo (verano). Una comparación establecida entre las tres flotas, mostró que la CPUE de los palangreros brasileños es la más alta respecto a la aguja blanca y el pez vela. Respecto a la aguja azul, los mayores valores de CPUE correspondían a los palangreros brasileños en 1995, a los palangreros de Barbados en 1996 y 1998 y a los palangreros de Honduras en 1997. Los rendimientos del pez vela mostraban un espectacular descenso entre 1976 y 1999 y las capturas más importantes tuvieron lugar en diciembre y enero. Las relaciones talla/peso obtenidas eran, aguja blanca:* $Wt = 1.05 \times 10^{-5} LJFL^{2.89}$, *aguja azul:* $Wt = 9.07 \times 10^{-7} LJFL^{3.44}$ *y pez vela:* $Wt = 4.95 \times 10^{-6} LJFL^{2.99}$. *Se presenta también información sobre las pesquerías deportivas de Brasil.*

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RÉSUMÉ

Le makaire bleu (Makaira nigricans), *le makaire blanc* (Tetrapturus albidus) *et le voilier* (Istiophorus platypterus) *sont capturés au large des côtes situées au sud et sud-est du Brésil par des palangriers brésiliens et des palangriers en location (embarcations battant le pavillon du Honduras et des Barbades), de Santos city, État de São Paulo, Brésil. Le présent document présente les statistiques de la flottille de Santos qui font état de la production annuelle de makaire bleu, makaire blanc et voilier pour 1971-99, la production mensuelle pour 1995-97, la CPUE annuelle pour 1995-99, ainsi que le poids moyen du makaire blanc pour 1992-95. Entre 1971 et 1991, la production annuelle du makaire blanc a indiqué une tendance à la hausse, suivie par une baisse progressive jusqu'en 1999. La moyenne annuelle du poids manipulé du makaire blanc a chuté, passant de 24,0-27,7 kg dans la période 1971-1984 à 18,6 kg en 1995. Le makaire bleu a été beaucoup plus sensible aux engins de palangre de faible profondeur qu'à la palangre normale, sa production et sa CPUE observant une forte augmentation entre 1995 et 1999, principalement pendant les mois d'été (de janvier à mars). Une comparaison des trois flottilles a indiqué que les palangriers brésiliens présentaient la CPUE la plus élevée pour le makaire blanc et le voilier. En ce qui concerne le makaire bleu, les plus fortes valeurs de CPUE ont été enregistrées par les palangriers brésiliens en 1995, par les palangriers des Barbades en 1996 et 1998, et par les palangriers honduriens en 1997. Entre 1976 et 1999, les captures de voilier ont considérablement chuté, les prises maximales intervenant en décembre et en janvier. Le rapport longueur (LJFL)/poids (Wt) obtenu pour le makaire blanc a été:* $Wt = 1{,}05 \times 10^{-5} LJFL^{2{,}89}$, *pour le makaire bleu:* $Wt = 9{,}07 \times 10^{-7} LJFL^{3{,}44}$, *et pour le voilier:* $Wt = 4{,}95 \times 10^{-6} LJFL^{2{,}99}$. *Des informations sont également données sur les pêcheries sportives brésiliennes.*

KEYWORDS

Tuna fisheries, Longlining, By catch, Sport Fishing, Fish catch statistics, Logbooks, Catch/effort, Length-weight relationships

INTRODUCTION

The Brazilian longliner fleet started operations with two boats in Santos, São Paulo State, Brazil, in 1965-66 (Arfelli and Amorim 1988), and then increased gradually until it reached a maximum of 23 boats in 1998. In 1992, some leased longliners with flags of Barbados, Honduras and Panama, began to operate in Santos City. In 1995, the number of boats reached 16 (13 Brazilian and 3 leased ones) and increased to 18 in 1996 (14 Brazilian and 4 leased ones), then to 15 (13 Brazilian and 2 leased) in 1997, becoming 23 boats in 1998 (16 from Santos City, 3 from Itajaí City and 4 leased). Nineteen boats operated in 1999 (16 Brazilian and 3 leased ones) and 12 until June 2000 (11 Brazilian and 1 leased).

In the 1971-99 period, the Santos fleet presented great variation in its fishing methods. From 1971 to 1994, all the boats used the traditional Japanese longline. Starting in the middle of 1994 there was a gradual substitution of the traditional longline by the shallow longline (monofilament with light stick for fish attraction) (Arfelli 1996). By 1996, all the Brazilian longliners were using the new equipment. The main target species in the 1970s were yellowfin, bigeye and albacore, later changing to sharks (blue shark mainly) and lately to swordfish (Arfelli *et al.* 1997).

From the 1960s to the 1970s, the tuna fleet from Santos operated in the area 20° - 33° S and 39° - 50° W. This area is associated with the presence of school of fishes of commercial value and within reach by autonomy of the boats. In this period, boats used to fish from the beginning of May to the middle of October to the south of latitude 25° S, and to the north of latitude 27° S in the other months (Arfelli and Amorim 1981). From 1979 on, the tuna boats kept following this schedule, but also operated in non-traditional areas for the season (Amorim and Arfelli 1984). The captains with more knowledge about the seasonality of fishing areas gradually fished where the abundance was higher and landed almost all the hooked fish (Amorim 1992). As a result, the area of operations was extended to 17° - 35° S and 27° - 52° W (Arfelli 1996).

Blue marlin (*Makaira nigricans*), white marlin (*Tetrapturus albidus*), and sailfish (*Istiophorus platypterus*), are caught off the south and southeast of the Brazilian coast all year round by the national and leased longline fleet from Santos (Amorim *et al*. 1994, Hazin *et al*., 1994, Antero-Silva *et al*., 1994). The present report contains analyses of this fleet with emphasis on blue marlin, white marlin and sailfish annual yield (for 1971-99), monthly yields (for 1995-97), Brazilian and leased (1995-98) yields, and annual CPUE (for 1995-99). White marlin annual average weights (1992-95), the relationships between length and weight of the three billfish species and some aspects of sport fishery are also provided.

MATERIALS AND METHODS

Captain's logbooks and interviews at the Fishing Terminal of Santos (TPS) were used for obtaining the annual yield and fishing effort of the Santos City fleet (Brazilian, Honduran and Barbadian longliners) from 1971 to 1999. Weight data were obtained from the commercial sheets kept by the fishing companies and by TPS.

The yield (metric tons - t), effort (per thousand hooks) and CPUE by weight (kilograms) of the Santos fleet are presented by year from 1995 to 1999; yield by month is also presented for the period 1995-97. The average weight of white marlin is presented by month for the years 1992-95.

In order to establish length-weight relationships based on the methodology of Miyake and Hayasi (1972) and Miyake (1990), the following data were obtained:

- 141 pairs of total weight and lower jaw-fork length (LJFL) of white marlin, collected from February 1974 to December 1997, at Santos, Vitoria (CEPEMAR 1990 and 1992), Cabo Frio and Ilhabela Cities;
- 87 pairs of LJFL and total weight of blue marlin, collected from October, 1974 to October, 1998, during three research trips on Santos longliners, and from tournaments of "Iate Clube do Espirito Santo-ICES" at Vitoria (CEPEMAR 1990 and 1992), "Iate Clube do Rio de Janeiro-ICRJ and Costa Azul Iate Clube-CAIC", Cabo Frio and "Yacht Club de Ilhabela-YCI" in Ilhabela Cities;
- 107 pairs of LJFL and total weight of sailfish collected from January 1974 to December 1998 during three research trips on Santos longliners, and from tournaments of Vitoria (CEPEMAR 1990 and 1992), Rio de Janeiro, Cabo Frio and Ilhabela Cities.

Blue marlin, white marlin and sailfish were tagged and released or sampled in the YCI, ICRJ, CAIC and ICES from October to February. The tags used were provided by the NMFS Southeast Fisheries Center, ICCAT and The Billfish Foudation.

RESULTS AND DISCUSSION

Santos fleet: Brazilian, Honduras and Barbados

In the years 1971-1999 longliners ranging from 25 to 192 TB and 22 to 52 TL (34 to 16 m long), presented great variation in fishing goals. From 1971 to 1994, all the boats used the traditional Japanese longline. Starting in the middle of 1994 there was a gradual substitution of the traditional longline for the shallow longline (Arfelli 1996), and, by 1996, all Brazilian boats were using the new equipment. In the beginning of the fishery the three tunas (yellowfin, bigeye and albacore) were the main target, changing sometimes to blue shark, mako shark and swordfish. Fishing effort increased due to the increase in the number of boats operating in the fishery, ranging from 600 thousand hooks in 1971-75, increasing to about one million in 1976-82, and reaching 2 million hooks in 1983-84. In the following years (1985-88) there was a reduction in the fleet by about one-half of the number of boats, and the effort decreased to one million hooks. From 1989 to 1994, there was a new increase according to Amorim *et al*. (1997).

Figure 1 contains the fishing effort (thousands of hooks) and the annual yield (t) for all grouped species unloaded by the Santos fleet in TPS from 1971 to 99. The figure shows an increasing trend in yield (530 to 3,252 t) and effort (432 to 2,572 thousand hooks) until 1990. The fishing effort continued to increase until 1993 (reaching 3,723 thousand hooks), but the yield did not follow this trend and it consequently decreased in the following period. Both yield and effort gradually decreased after 1990 reaching 1,889 t and 1,025 thousand hooks in 1996. From 1995 to 1999, yield and effort followed the same trend.

White Marlin

In spite of the occurrence of *Tetrapturus audax*, in the study area cited by Ueyanagi and Wares (1975), this species has not been seen from 1974 to the present time. All year round, white marlin presents pectoral, dorsal and anal fins, like *Tetrapturus audax*, but the anus position similar to white marlin. John Graves (Virginia Inst. Mar. Sci., personal communication) while studying the mitochondrial DNA of fish hearts, concluded that white marlins off the Brazil and USA Atlantic coasts belong to the same population (Amorim *et al*. 1998).

Observing the annual yield of Brazilian and leased Santos longline fleet, white marlin showed an increasing trend from 1971 (16 t) to 1991 (270 t). It gradually declined in subsequent years until 1999 (when yield reached 47 t), as shown in Figure 2.

The highest abundance of white marlin is during the fourth quarter (Antero-Silva *et al*. 1994). From 1995 to 1997, white marlin presented the highest catch in November, December and January (Figure 3).

Comparing the CPUE obtained by boats of different flags, the highest CPUE for white marlin was 378 kg per thousand hooks for Brazilian longliners (Figure 4).

From 1995 to 1999, white marlin yield showed small fluctuations, ranging from 47 t in 1999 to 63 t in 1995 as shown in Figure 5. From 1995 to 1999, the CPUE of white marlin ranged from 23 to 57 kg per thousand hooks (Figure 6).

According to Arfelli *et al*. (1986) during the 1971-84 period the annual average dressed weight of white marlin caught by the Santos fleet fluctuated from 27.7 to 24.0 kg until 1983, decreasing to 21.1 kg in 1984. For the 1992-95 period, dressed weight fluctuated from 22.2 to 18.6 kg (Amorim *et al*. 1998).White marlin average dressed weight presented small variation from 22.2 kg (26.6 kg total weight) in 1993 to 18.6 kg (22.3 kg total weight) in 1995 (Figure 7). In May 1993 and April 1994 average weights showed greater variation (40 kg and 35 kg, respectively).

The LJFL-total weight relationship obtained for white marlin was (Figure 8): $Wt = 1.05 \times 10^{-5} LJFL^{2.89}$ ($r^2 = 0.825$, N = 141). The lower jaw fork length and total weight ranged from 150 to 224 cm and 19 to 64 kg.

Blue Marlin

In the study area, all large marlins are blue marlin. The occurrence of black marlin, *Makaira indica* (Miyake and Hayasi 1972, Nakamura 1975), has never been registered by the authors from 1974 to present.

According to Amorim *et al*. (1998), blue marlin yield fluctuated from 3 t in 1973 to 26 t in 1989. Figure 2 shows that blue marlin catches were around 10 t per year from 1971 to 1990 and gradually increased from 1991 to 1999 up to 76 t.

The highest abundance of blue marlin occurs during the first and fourth quarters (Amorim *et al*. 1994).Analyzing the monthly CPUE for 1971-95 from the Santos fleet that used traditional longline, it was observed that blue marlin is more abundant from October to March.Based on the 1995-97 period,

blue marlin presented the highest monthly catch in January to March (Figure 3).The highest Santos fleet CPUE in the period 1971-95 was recorded in the first quarter of 1992-95 (132.0 kg per thousand hooks) and in the fourth quarter of 1986-89 (96.1 kg per thousand hooks) with traditional longline, and in the fourth quarter of 1994-95 (101.5 kg per thousand hooks) with shallow longline. Comparing the two gears, shallow longline showed the highest CPUEs (Amorim *et al*. 1998).

Comparing the CPUE from Brazilian and leased longliners, the Brazilian fleet generally presented the highest catch of billfish (Figure 4), except in 1996 (Barbados flagged boats), 1997 (Honduran flag) and 1998 (Barbadian flag) when blue marlin CPUE was higher for the other vessels. The highest CPUE of blue marlin was 262 kg per thousand hooks (by Brazilian boats, Figure 4).

From 1995 to 1999, blue marlin yield showed a small fluctuation ranging from 46 t to 76 t (Figure 5). From 1995 to 99, the CPUE for blue marlin has ranged from 19 to 57 kg per thousand hooks (Figure 6).

The LJFL-total weight relationship of blue marlins obtained was (Figure 9): $Wt = 9.07 \times 10^{-7} LJFL^{3.44}$ ($r^2 = 0.944$, N = 87). The minimum and maximum lengths and weights were respectively 160 cm and 22 kg and 345 cm and 428 kg.

Sailfish

Every year sailfish migrate from the north to south-southeast of Brazil, in order to spawn between the latitudes 20º and 27º S, and longitudes 39º and 48º W. Sailfish usually appear from October to March and occasionally in September. During this period, the monthly sailfish catches in weight from November to January were about 14%, 27% and 10% of the total catches, respectively (Arfelli and Amorim, 1981).

Sailfish catches gradually increased from 1971 (43 t) to 1986 (187 t) and showed afterwards a dramatic decline to 10 t in 1999, with a peak of 114 t in 1976 (Figure 2).

Sailfish were caught mainly in the fourth and first quarters and they disappeared in the second and third quarters (Hazin *et al*., 1994). Sailfish catches were highest mainly in December and January (Figure 3).

Comparing the CPUE of Santos longliners of all flags, the highest CPUE for sailfish was for Brazilian longliners (194 kg, Figure 4).

From 1995 to 99, sailfish yield showed small fluctuations (Figure 5). From 1995 to 99, sailfish CPUE ranged from 6 to 17 kg per thousand hooks (Figure 6).

The LJFL-total weight relationship obtained for sailfish was (Figure 10): $Wt = 4.95 \times 10^{-6} LJFL^{2.99}$ ($r^2 = 0.801$, N = 107). The lower jaw fork lengths and total weights ranged from 141 to 193 cm and 13.6 to 32 kg.

Sport Fishery

In São Paulo State, only the Yacht Club of Ilhabela (YCI, Ilhabela City), holds tournaments of sport fishing for blue and white marlins and sailfish. In the 1998/99 season, the club held 10 tournaments, 2 of which were tag and release. For all tournaments, a minimum blue marlin weight of 120 kg was adopted. For the seasons of 1998/99 and 1999/00, YCI adopted a new minimum weight of 150 kg for blue marlin and dictated the release of all white marlin and sailfish hooked. Anglers from Iate Clube do Espírito Santo (ICES, Vitória City), have been releasing white marlin smaller than 50 kg, blue marlin smaller than 150 kg and sailfish smaller than 35 kg for more than three years. In Cabo Frio, Costa Azul Iate Clube (CAIC) held five tournaments (two tag and release ones). Iate Clube of Rio de Janeiro (ICRJ) has been releasing blue marlin smaller than 200 kg for 3 years (this is also the case in Cabo Frio). For the 1998/99

season, ICRJ released all billfish hooked. From 1993 to 1998, 304 billfish were tagged and released in the tournaments of YCI, ICRJ, CAIC and ICES. Of these, 263 were sailfish, 27 blue marlins and 14 white marlins. Seventy-eight young swordfish have been also tagged and released by Santos longliners since 1978. Three tagged fish were recaptured (1 swordfish after 11 years and three months, 1 sailfish after 2 months and 1 white marlin after 4 years). Table 1 shows the yield of billfish, in the season of 97/98 of YCI.

The number of fishing days number by ICRJ yacht, is shown in Table 2. During the tournament of January 23rd 1999, one blue marlin weighing 546.8 kg was caught.

The rules for the 1999/2000 fishing season in YCI establish that all billfishes be released, and this is also the rule for Rio de Janeiro (only fish of probable record size can be brought on board). In the tournaments of ICRJ, only blue marlin over 250 kg can be brought on board. In the tournaments of Cabo Frio-Rio de Janeiro, almost 100% of the billfish were released.

CONCLUSIONS

The annual yield and CPUE of all grouped species from Santos fleet showed an increasing trend until 1990. The fishing effort continued increasing until 1993 but the yield did not follow and it consequently decreased in the subsequent period. From 1995 to 1999 yield and effort followed the same trend.

White marlin annual yield showed an increasing trend from 1971 to 1991, and gradually declined until 1999. During 1995-97, white marlin presented the highest catches in November, December and January (Spring to Summer).

Of the boats in the fleetshe Brazilian-flagged longline vessels showed the highest CPUE for white marlin and sailfish.

The annual average dressed weight of white marlin showed a decrease from 24.0 - 27.7 kg (28.8 - 33.2 kg total weight) in the 1971-83 period, to 18.6 kg (22.3 kg total weight) in 1995.

Blue marlin was much more susceptible to the shallow longline than to the regular longline, showing a great increase in yield and CPUE from 1995 to 1999, mainly between January and March (Summer months). The greatest values of blue marlin CPUE were obtained by Brazilian, Barbados and Honduran flagged boats.

Sailfish yields presented a dramatic decline from 1976 to 1999 and the highest catches occurred in December and January.

The sport fishing of Iate Clube of Rio de Janeiro, Yacht Club of Ilhabela, Iate Clube do Espírito Santo and Costa Azul Iate Clube caught great quantities of blue, white marlin and sailfish. Since the 1994/95 fishing season these clubs have been releasing part of the billfish that are hooked. At the present time, anglers from almost all clubs release all sailfish smaller than 50 kg, white marlin, and <150 kg blue marlin. Also tag and release activity is increasing. Three tagged fish were recaptured (1 swordfish after11 years and three months, 1 sailfish after 2 months and 1 white marlin after 4 years).

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Table 1. Yield (total weight) of billfish caught during the season 97/98 by the sport fishery of YCI.

Sailfish	877 kg .
White marlin	174 kg .
Blue marlin	2,816 kg .

Table 2. Number of fishing days and billfish caught during the season 97/99 by the sport fishery of ICRJ.

DATE	FISHING DAY PER YACHT	SAILFISH	WHITE MARLIN	BLUE MARLIN
97/98	42/12	622 caught 26 released	25 caught	03 caught 26 released
98/99	55/13	119 caught 885 released	20 caught 24 released	03 caught 12 released

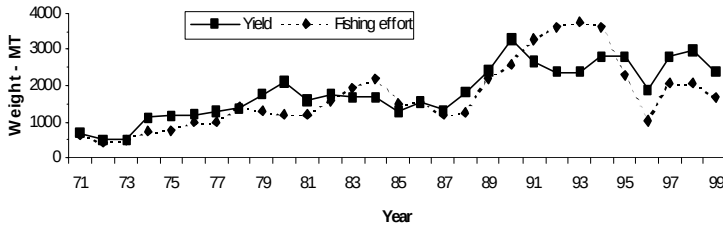

Figure 1. Annual yield and fishing effort for the national and leased fleets of Santos.

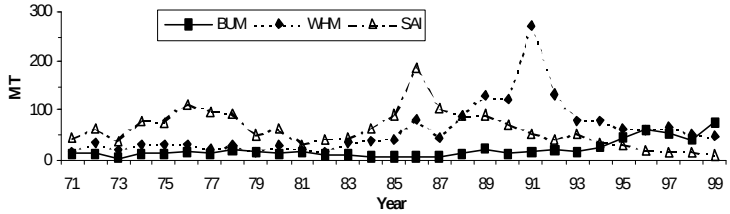

Figure 2. Santos fleet annual yields of blue marlin, white marlin and sailfish.

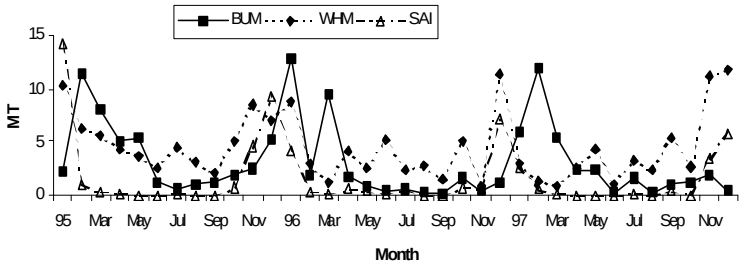

Figure 3. Monthly yields of blue marlin, white marlin and sailfish (1995-97).

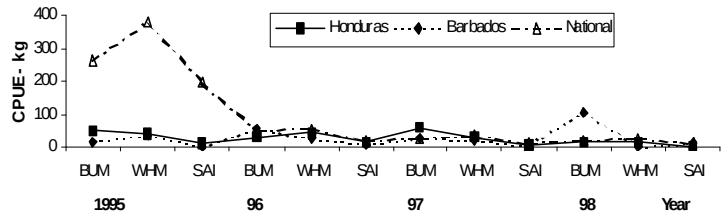

Figure 4. Monthly CPUE (kg/1000 hooks) of blue marlin, white marlin and sailfish for the various fleets (1995-98).

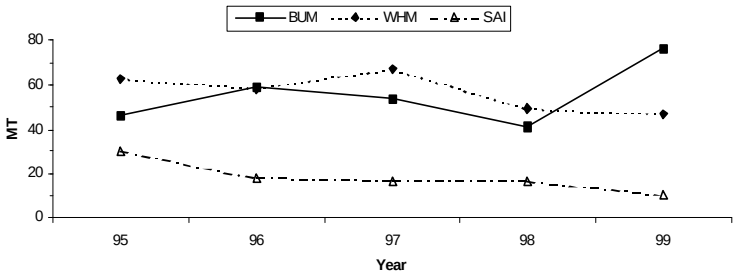

Figure 5. Blue marlin, white marlin and sailfish annual yield (t) from Santos fleet (1995-99).

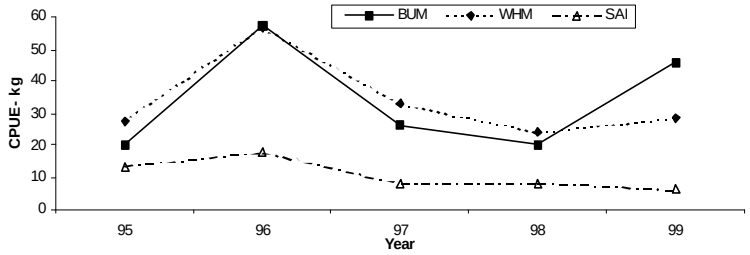

Figure 6. Blue marlin, white marlin and sailfish annual CPUE (kg/1000 hooks) from Santos fleet (1995-99).

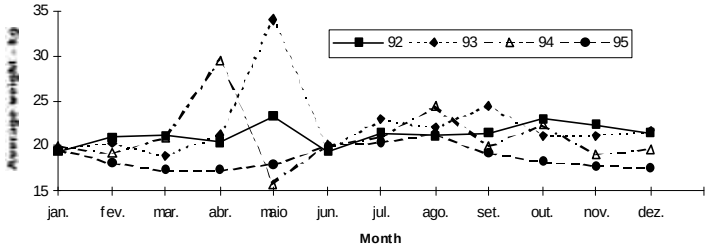

Figure 7. White marlin monthly mean weight (kg).

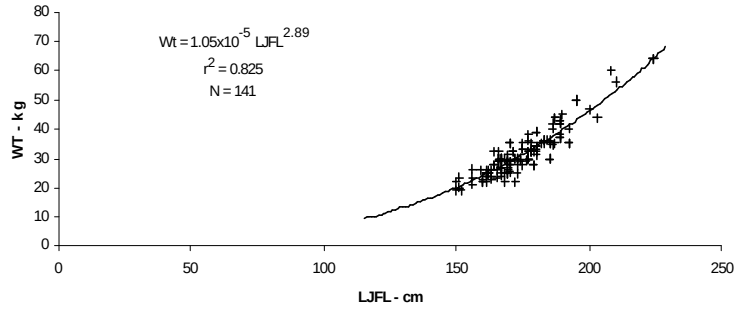

Figure 8. Lower jaw-fork length / total weight relationship for white marlin caught off the south and southeast coasts of Brazil.

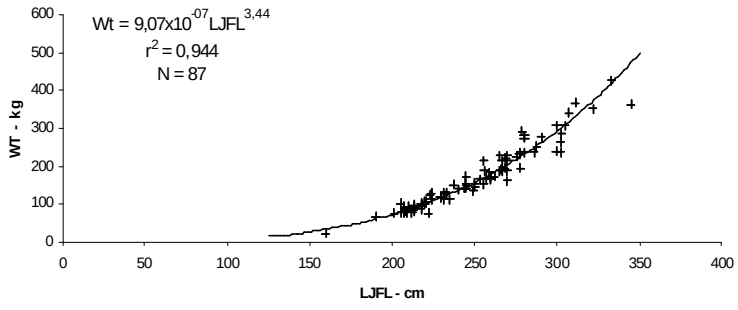

Figure 9. Lower jaw-fork length / total weight relationship for blue marlin caught off the south and southeast coasts of Brazil.

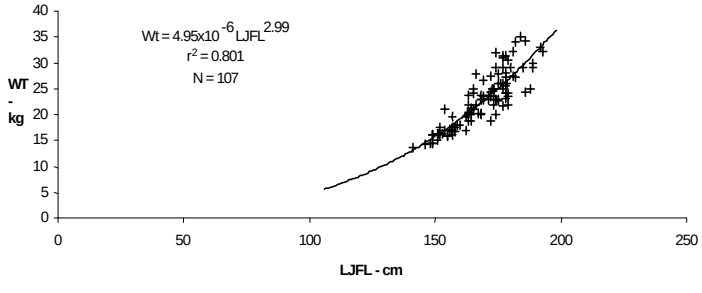

Figure 10. Lower jaw-fork length / total weight relationship for sailfish caught off the south and southeast coasts of Brazil.