

## THE EVOLUTION OF TUNA FISHERY IN SANTOS-SÃO PAULO, SOUTHERN BRAZIL (1971-95)<sup>1</sup>

Amorim, A.F.<sup>2</sup>, F.M.S. Braga<sup>3</sup>, L. Fagundes<sup>2</sup>, F.E.S. Costa<sup>2</sup>, C.A. Arfelli<sup>2</sup>

### SUMMARY

The tuna boats based at Santos, Sao Paulo State, mainly catch tuna and swordfish, sharks and other bony fish as by-catch, off the south and southeast of Brazil (15°-35°S and 30°-50°W). This yield followed the trend of increasing fishing effort from 1971 to 1990 when it reached its highest value (3,250 MT). After this period, effort continued to increase until 1993 (3.9 million hooks), in spite of the decrease in yield. In 1994, there was a decrease in effort, although the second highest yield was recorded (2,805 MT). Shark landings, which used to be about 11% (1971-1974) showed a gradual increasing trend, and reached 50% (1993) of the total catch of these longliners. Blue shark was an important fishing resource and was responsible for the increase in shark yields. It was the main species caught from 1983 to 1993, except for 1988. Probably, at least part of the time, blue shark was the main target of this fishery, representing about 30% of the total catch during the 1984-1994 period. In addition, other sharks represented about 15% of the catch, as follows: shortfin mako, bigeye thresher, scalloped and smooth hammerheads, night and bull, spinner, silky, black, dusky, sandbar sharks, and oceanic whitetip.

### RÉSUMÉ

Les thoniers basés à Santos (Etat de Sao Paulo) capturent principalement des thonidés et des espadons, et accessoirement des requins et autres poissons osseux, au large des côtes Sud et Sud-Est du Brésil (entre 15°-35° S et 30°-50° O). La production a suivi la tendance à la hausse de l'effort de pêche entre 1971 et 1990, année où la production a été la plus élevée (3250 TM). Par la suite, l'effort a continué à augmenter jusqu'en 1993 (à 3,9 millions d'hameçons) mais la production a diminué. En 1994, malgré une diminution de l'effort, on a enregistré la deuxième valeur la plus élevée (2805 TM). Les débarquements de requins, qui étaient d'environ 11% entre 1971 et 1974, ont augmenté progressivement jusqu'à atteindre 59% des captures totales des palangriers (en 1993). Les captures de requin bleu, qui étaient déjà importantes, ont provoqué l'augmentation des captures de requins. Il s'agit en effet de l'espèce la plus capturée entre 1983 et 1993, à l'exception de l'année 1988. Le requin bleu est probablement, au moins dans certaines occasions, la cible principale de la pêcherie. Il représente en effet 30% de la capture totale entre 1984 et 1994. Les autres requins (requin taupe-bleu, requin renard à gros yeux, requin marteau halicorne, requin marteau-commun, requin de nuit, requin bouledogue, requin tisserand, requin blanc soyeux, requin sombre, requin de sable, requin gris et requin océanique) représentent environ 15% des captures.

### RESUMEN

Los barcos atuneros con base en Santos, Estado de Sao Paulo, capturan sobre todo túnidos y pez espada, tiburones y otros osteictios, como captura fortuita, frente al sur y sudeste de Brasil (15°-35°S y 30°-50°W). Este rendimiento siguió una tendencia hacia el aumento del esfuerzo de pesca desde 1971 a 1990, año en que alcanzó su valor mas alto (3.250 t). A continuación, el esfuerzo siguió en alza hasta 1993 (3,9 millones de anzuelos) a pesar de la disminución del rendimiento. En 1994 se observó un descenso del esfuerzo, pero se obtuvo la segunda cifra mas alta de rendimiento (2.805 t). El desembarque de tiburones, que solía ser del 11% (1971-74) siguió una tendencia al aumento llegando al 59% (1993) de la captura total de estos palangreros. La tintorera era una especie importante y contribuyó al incremento del rendimiento en tiburones. Fue la especie mas pescada entre 1983 y 1993, exceptuando el año 1988. Probablemente, al menos parte del tiempo, la tintorera fue la especie-objetivo de esta pesquería, representando el 30% de la captura total en el período 1984-94. También, otros tiburones representaron alrededor del 15%: tiburón maco, zorro ojón, cornuda común y pez martillo, tiburón nocturno y cazón de leche, *Carcharynnus brevipinna*, tiburón sedoso, tolo, tiburón arenoso, tiburón de Milbert y tiburón oceánico.

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<sup>2</sup> Instituto de Pesca. Av Bartolomeu de Gusmão, 192 Santos-SP, 11030-906 Brasil.

<sup>3</sup> UNESP, Depto. de Zoologia. C.P. 199, Rio Claro-SP, 13506-900 Brasil.

## INTRODUCTION

The tuna boats based in Santos-SP, begun in 1958 with the leasing of three Japanese boats and continued until 1961 (MORAES, 1962; LIMA & WISE, 1963; MORAIS, 1963; BARROS & FONSECA, 1965; WISE & DAVIS, 1973; PAIVA & LE GALL, 1975). In 1965/66 the tuna fishery started again with two Brazilian boats (ARFELLI & AMORIM, 1988) increasing gradually until reaching the number of 16 boats.

These boats operated with Japanese longline (AMORIM & ARFELLI, 1984), that had a few changes until 1993, like substituting imported material for Brazilian one. In the 80's the GPS (Global Position System) was the most important equipment bought by the mentioned fleet, that permitted a more accurate positioning, and consequently a better knowledge of the area and season for catching the species. Just in 1994 part of this tuna fleet changed the fishing gear, starting to use the reel with monofilament.

From 1965/66 to the 70's, the tuna fleet from Santos operated in the area 20°-33° S and 39°-50° W. This area is related to the presence of school of fishes with commercial value and autonomy of the boats. In this period they used to fish from the beginning of May to middle of October, to the South of latitude 25° S, and to the North of latitude 27° S in the other months (ARFELLI & AMORIM, 1981). From 1979 on the tuna boats kept following the mentioned schedule, but also operated in non-traditional areas for the season (AMORIM & ARFELLI, 1984). The captains, with more knowledge of the seasonality of fishing areas, gradually fished were the abundance was higher and landed almost all the fish hooked (AMORIM, 1992). So the mentioned area was extended to 15°-35° S and 30°-50° W.

In this paper the statistic data of the main species and by-catch caught by the tuna fleet based in Santos is analysed from 1971 to 1994.

## MATERIAL AND METHODS

The number of fish by species, and fishing effort was obtained from the logbooks written by the captains of the tuna boats. The individual weight per trip was taken from the commercial sheets from the fishing companies "Irmãos Ono, Kawai-Suisan Comércio e Indústria de Pescado Ltda.", and "Cooperativa Mista de Pesca Nipo-Brasileira".

Other information like kind of bait used, catch of different fish, presence of other boats operating in the same area were obtained in interviews with the fishermen during the landing in the Fishing Terminal of Santos.

The fishing effort in number of hooks was obtained through the logbooks or interview with the captain and fishermen of the boats (ARFELLI & AMORIM, 1981; AMORIM & ARFELLI, 1984; AMORIM, 1992).

## RESULTS AND DISCUSSION

The fleet from Santos, increased from 3 boats in 1971 to 8 in 1984, decreasing to 6 in 1985, and had kept the same number until 1987 (ARFELLI & AMORIM, 1988). From 1988 to 1993 this fleet increased to 16 boats, 14 national and 2 leased boats, 5 were made of wood and 11 of steel. In 1991 and beginning of 1992 two leased boats, based in other state, sometimes landed in Santos (ARFELLI & AMORIM, 1994). Until January 1996, the fleet comprised 13 national and 3 leased boats (two with Barbados' flag and one with Honduras' flag). These boats are about 30 m long.

From the beginning of the fisheries until 1987 the mentioned fleet used Japanese longline with 300 baskets and 1,500 hooks (about 90 km of main line) comprised by baskets with 5 hooks, reaching depths of about 60 to 120 m. From 1988 up to now they started using up to 8 hooks by basket, increasing the depth to about 150 m. The main baits used were sardine, squid and Spanish mackerel. In June 1994, some boats changed the traditional longline for the reel of monofilament, using squid as bait, and one way light sticks, targeting the catch of the swordfish. This new fishing equipment reduced the number of fishermen from 17 to 11 and from 1,500 hooks per setting, to about 800, operating in depths of about 30 m.

In the beginning of the studied period (1971-79) the main targets of the tuna boats from Santos were the three species of tuna, representing about 55% of the total catch, where the most important species was the yellowfin. The swordfish has always been the second most caught species (in weight) and sometimes the first (1974, 1975, 1980, 1982, 1988, 1994 and 1995). The tuna boats used to set the longline at 1:00 in the morning, with sardines as bait, aiming the catch of tunas. In the mid 80's and in the first half of 1981, this fleet aimed their fisheries to swordfish, setting their hooks at about 8:00 PM, using squid as bait (AMORIM & ARFELLI, 1984). Sometimes swordfish used to be the target species until 1994. From June 1994 they started changing the traditional longline by the monofilament, aiming the catch of swordfish. In October 1995 seven boats were operating with this new equipment.

It was observed that the season of the main species, e.g., for yellowfin is from October to December, the albacore and bigeye from April to September. The swordfish is more abundant from June to October and the blue shark from April to September.

The fishing effort increased due to the increase in number of boats operating, ranging from 600 thousand hooks (1971-75) to about one million (1976-82), and in the consecutive years (1983-84) reached the amount of 2 million hooks. In the following years (1985-88) there was a reduction in the fleet, for about half the number of boats, and the effort decreased to one million hooks. From 1989 to 1994, there was a new increase, and the effort ranged from 2.5 to 3.9 million of hooks (Figures 1 and 2).

The tuna yield increased from the annual average of 580 t (1971-73) to about 1,200 t from 1974-78 to 1,600 t in 1979-88, and to 2,600 t in 1989-94, reaching the maximum of 3,252 t in 1990 (Figures 1 and 2).

The total tuna catch per unit of effort (in weight) (CPUE), in the analysed period presented a decreasing tendency, inversely to the increase of the yield and effort (Figure 2).

Figure 3 shows the fluctuation on the catch of three species of tuna during the whole period. Yellowfin was the most abundant of the three species, presenting the highest production, 615 t (1979), decreasing to 96 t (1994). Bigeye presented the highest catch (232 t) in 1978, occurring also a decrease in yield in 1992 and 1994 (28 and 37 respectively). The highest catch of albacore was 164 t (1980), decreasing to 56 and 72 t (1993 and 1994 respectively).

The percentage of swordfish catch kept in a constant level during the analyzed period. The great increase verified in 1980 was probably due to changes in the kind of bait used and the schedule of setting the longline. It was also observed a great increase in catch in 1994 (Figure 4), due to the change of fishing gear, substituting the traditional longline by the longline with reel of monofilament.

From 1971 to 1974, the percentage of shark catch was about 11%, increasing to 59% in 1993 (Figure 4). The blue shark was the species that was more caught, representing about 30% of the total catch in the period 1983-88 (Figures 1 and 5), after an increase of the price in the meat market. The yield followed the tendency of the fishing effort until 1990, when it reached its highest value (899 t). After this period, the effort kept increasing until 1993, but the blue shark annual yield kept stable around 890 t (1991-4), showed in Figure 1. The blue shark CPUE in number and weight showed an increase from 1971 to 1985 and a slight decreasing trend until 1994, although the highest CPUE occurred in 1990. The decreasing CPUE trend after 1985 can indicate a decrease in the stocks of blue shark. As the blue shark is not the target species of this fishery, and is widely distributed around the world, this variations observed in the CPUE can be a result of the changes of target species (Figures 6 and 7). The decrease in the average annual weight of blue shark, observed from 1971 to 1981 was probably due to the discarding of small fish occurred in the beginning of the period (Figura 8). After 1982, when the fish started to be sold, due to a good price in the market, the average dressed weight (weight without fins, head gill and gut) was around 30 kg. Also the other sharks that were discarded started to be landed and sold in the market. Table I showed a list of sharks and rays caught by Santos longliners according to the percentage of occurrence and by-catch disposition.

Besides the raise of the average price of the shark meat, another advantage in its catch is the high market value of the fins, sold during the landing (in cash) by the crew that shares the profits among themselves.

Through the analysis of the tuna boat catch in Santos, a clear alternation of the target species between sharks and tunas is observed. From 1980 to 1994 a decrease in the tuna catch is seen, becoming less than 10% of the total catch, while the sharks started representing the highest percentage of the yield.

#### CONCLUSIONS

The total yield of the tuna fleet from Santos-São Paulo, gradually increased in the studied period, after an increase in the fishing effort, proportional to the number of operating boats. Opposite to this fact, the total tuna CPUE showed an increased trend only from 1971 to 1980 and decreasing after this period.

The main target of the fleet varied during the studied period, starting with tunas, and changing to sharks. Blue shark was responsible for the sharks raise and its CPUE has an increase until 1990, decreasing until 1994. Another target species was the swordfish, that was constantly caught during the same period, and the variations observed were due to changes in the fishing gear, kind of bait used and schedule for setting the longline.

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TABLE 1. Relative abundance of sharks and rays from Southern Brazil, based in Santos longliners.

Scientific names	Percentage			By-catch disposition	
	high	low	rare	retained	discarded
<b>SHARKS</b>					
<i>Prionace glauca</i>	x			x	
<i>Isurus oxyrinchus</i>	x			x	
<i>Alopias superciliosus</i>	x			x	
<i>Sphyrna lewini</i>	x			x	
<i>Sphyrna tigrina</i>	x			x	
<i>Carcharhinus signatus</i>	x			x	
<i>Carcharhinus maou</i>	x			x	
<i>Alopias vulpinus</i>		x		x	
<i>Carcharhinus brevipinna</i>		x		x	
<i>Carcharhinus falciformis</i>		x		x	
<i>Carcharhinus leucas</i>		x		x	
<i>Carcharhinus obscurus</i>		x		x	
<i>Carcharhinus plumbeus</i>		x		x	
<i>Carcharhinus altimus</i>		x		x	
<i>Carcharhinus brachyurus</i>		x		x	
<i>Carcharhinus perezii</i>		x		x	
<i>Carcharhinus porosus</i>		x		x	
<i>Carcharias taurus</i>		x		x	
<i>Etmopterus gracilispinis</i>			x		x
<i>Galeocerdo cuvieri</i>			x		
<i>Heptanchias perlo</i>			x		x
<i>Hexancus griseus</i>			x		x
<i>Isistius brasiliensis</i>			x		x
<i>Isistius plutodus</i>			x		x
<i>Isurus paucus</i>			x		
<i>Lamna nasus</i>			x		
<i>Megachasma pelagios</i>			x		
<i>Odontaspis noronhai</i>			x		x
<i>Pseudocarcharias kamoharui</i>			x		x
<i>Rhincodon typus</i>			x		x
<i>Sphyrna mokarran</i>			x		
<i>Squaliolus laticaudus</i>			x		x
<b>RAYS</b>					
<i>Dasyatis violacea</i>			x		x
<i>Mobula hypostoma</i>			x		x

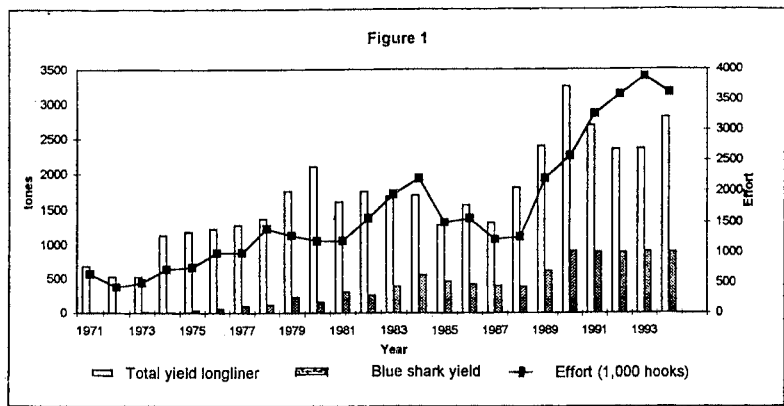


Figure 1: Total yield (t), blue shark yield (t) and fishing effort (1,000 hooks), of Santos longliners.

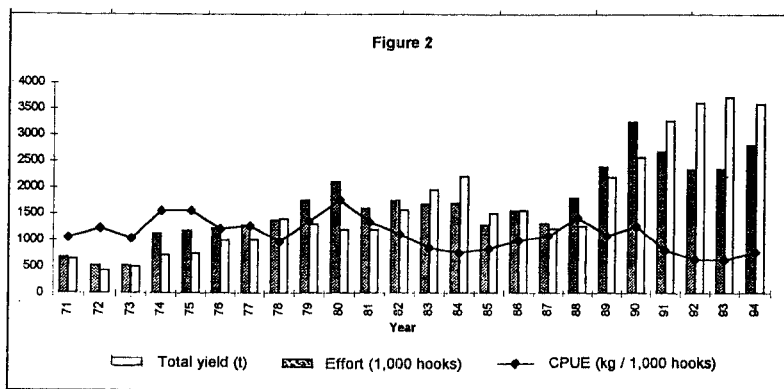


Figure 2: Total yield (t), fishing effort (1,000 hooks) and CPUE (kg per thousand hooks), of Santos longliners.

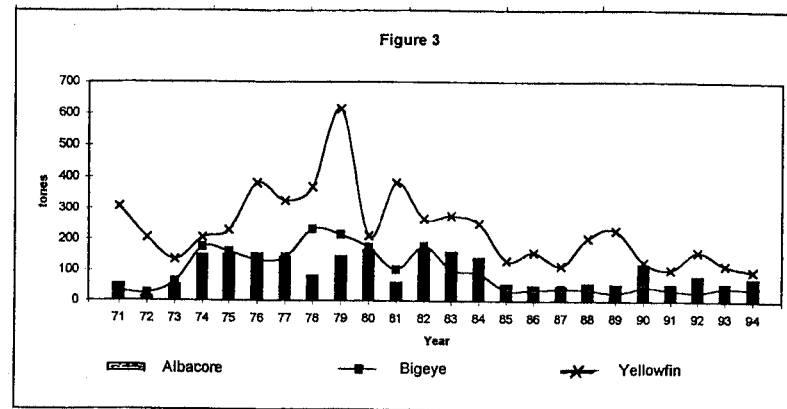


Figure 3: Albacore, bigeye and yellowfin yield of Santos longliners.

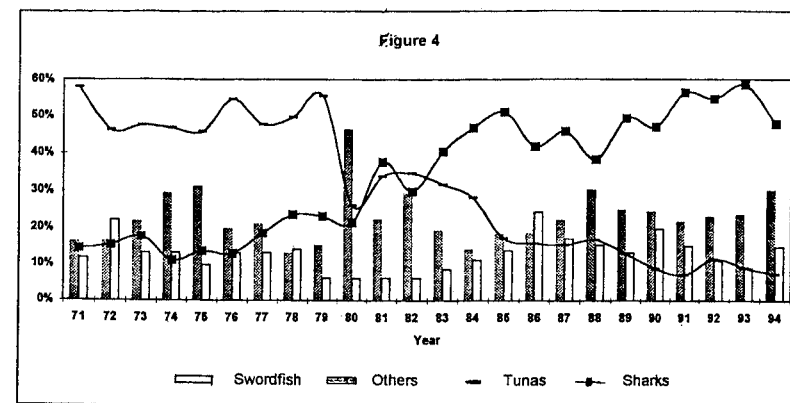


Figure 4: Percentage of swordfish, tunas, sharks and others of Santos longliners.

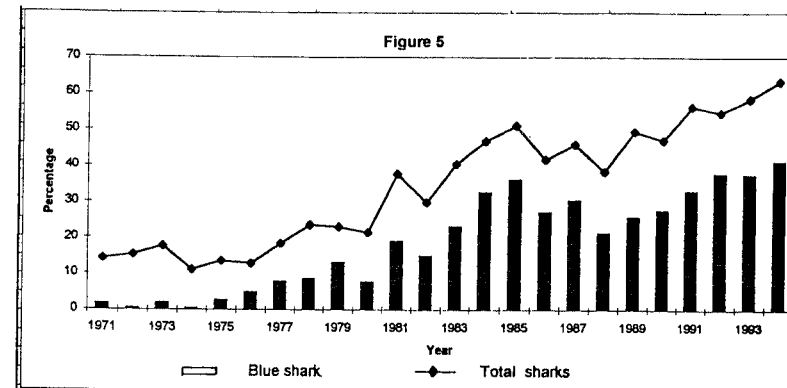


Figure 5: Percentage of blue shark and other sharks of Santos longliners.

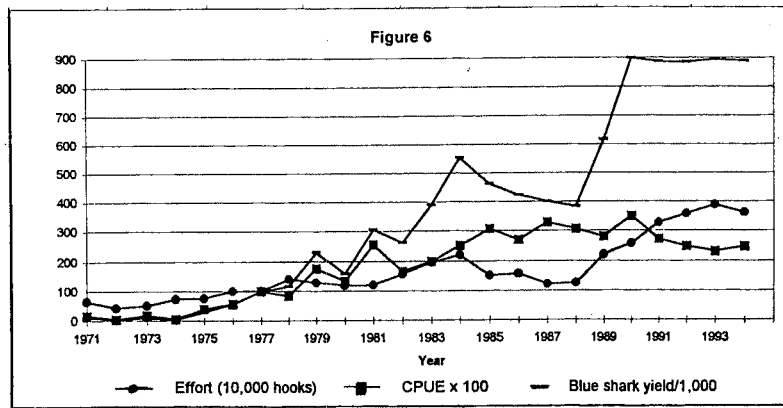


Figure 6: Blue shark yield, fishing effort and CPUE (weight) of Santos longliners.

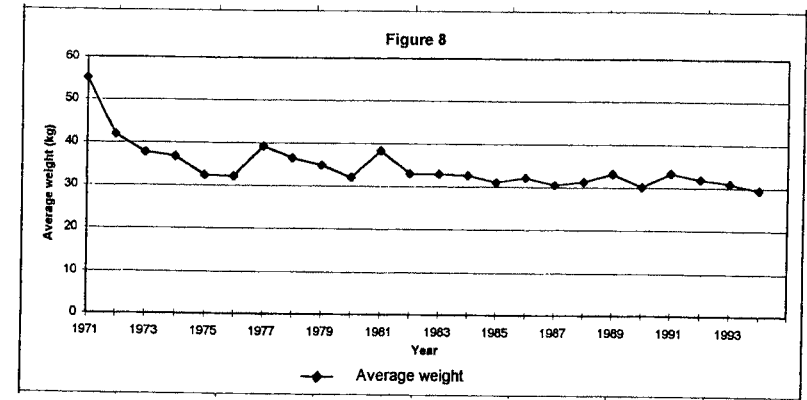


Figure 8: Blue shark average weight of Santos longliners.

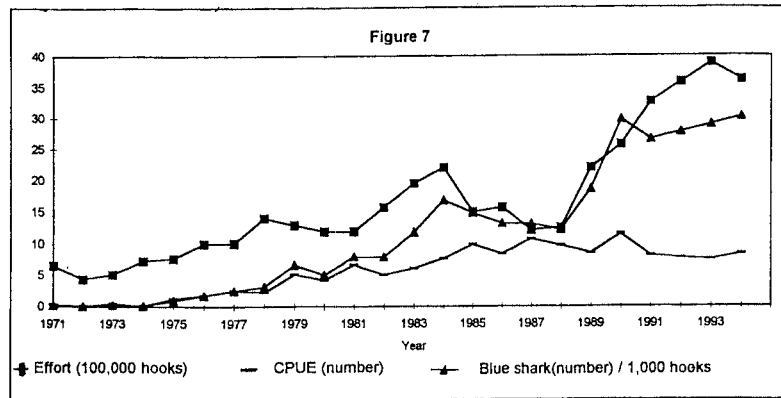


Figure 7: Blue shark catch (number), fishing effort and CPUE (number) of Santos longliners.

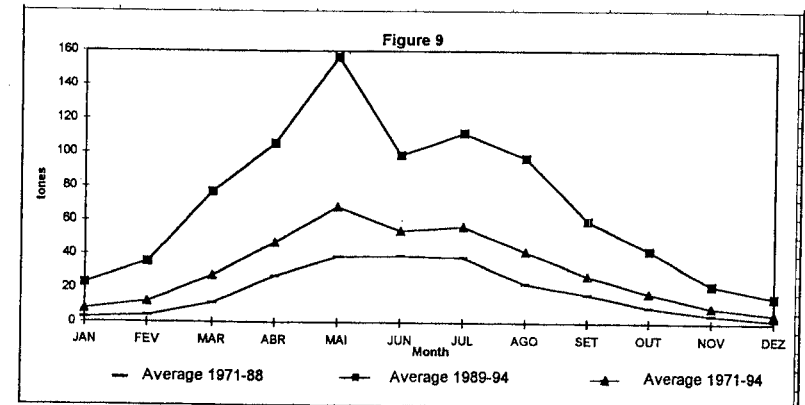


Figure 9. Blue shark monthly yield from 1971-88, 1989-94 and 1971-94 of Santos longliners.