

## ANALYSIS OF SMALL-SIZE FLEET FISHERY BASED IN CABO FRIO CITY, RIO DE JANEIRO-BRAZIL (2003-2012)

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### SUMMARY

*Multispecific small-fleet in Southwestern Atlantic (Cabo Frio City, Rio de Janeiro-RJ State, Brazil) is comprised by small boats that catch 15% of RJ total yield. Stimulated by the productivity caused by the upwelling water, landing facilities and Cabo Frio City industries, since 2000, this fleet has been growing in number of boat reaching the number of 350 vessels in 2010. It represents an important fishing area off Rio de Janeiro State (22° S to 24° S and 40° W to 44° W), and the total production from 2003 to 2012 was 2,752 tons. The target species was mainly the dolphinfish using surface longline. The sailfish was also caught by surface longline and the yellowfin tuna was captured basically by hand line, while the little tuna was mostly caught by small purse seine. The analysis also includes length frequency of size distribution of the dolphinfish, sailfish, yellowfin and little tuna from 2003 to 2012.*

### RÉSUMÉ

*La flottille plurispécifique de petite taille opérant dans l'Atlantique Sud-Ouest (ville de Cabo Frio, état de Rio de Janeiro, Brésil) se compose de petits bateaux qui capturent 15% de la production totale de Rio de Janeiro. Stimulée par la productivité causée par la remontée de l'eau, les installations de débarquement et les industries dans la ville de Cabo Frio, depuis 2000 cette flottille augmente en nombre de navires, atteignant le chiffre de 350 navires en 2010. Il s'agit d'une importante zone de pêche au large de l'état de Rio de Janeiro (22° S à 24° S et 40° W à 44° W), la production totale de 2003 à 2012 s'élevant à 2.752 t. L'espèce cible était principalement la coryphène commune capturée à la palangre de surface. Le voilier était également capturé à la palangre de surface et l'albacore à la ligne à main, tandis que la thonine commune était essentiellement capturée par de petits senneurs. L'analyse inclut aussi la distribution des fréquences de taille de la coryphène commune, du voilier, de l'albacore et de la thonine commune de 2003 à 2012.*

### RESUMEN

*La pequeña flota multiespecífica del Atlántico sudoccidental (Cabo Frío, Río de Janeiro-Estado RJ, Brasil) se compone de pequeños barcos que capturan el 15% de la producción total de Río de Janeiro. Estimulada por la productividad causada por el afloramiento, las instalaciones de desembarque y las industrias de Cabo Frío, desde 2000 esta flota ha ido creciendo en número de barcos, alcanzando los 350 en 2010. Representa una importante zona de pesca en aguas del Estado de Río de Janeiro (22° S a 24° S y 40° W a 44° W), y la producción total desde 2003 hasta 2012 fue de 2.752. La especie objetivo era principalmente el dorado usando el palangre de superficie. El pez vela se captura también mediante el palangre de superficie, el rabil se captura básicamente con liña de mano y la bacoreta se captura principalmente con pequeños cercos. El análisis incluye también la distribución de la frecuencia de tallas del dorado, el pez vela, el rabil y la bacoreta desde 2003 a 2012.*

### KEYWORDS

*Capture fishing, Fishing gear, Multispecies fisheries, Catch composition, Commercial fishing*

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## 1. Introduction

The small-size fleet of Cabo Frio City, Rio de Janeiro-RJ State, Brazil represented 15% of RJ total yield (Marques *et al.*, 2000). The water high productivity, landing facilities around Araruama Lake and exportation industries, Cabo Frio City has about 350 boats of small-size fleet. These boats usually ranging from 12 to 15 meters and under 20 TM, comes from another regions and States. This fleet during the year directs their fishery to different fish species and use variety of equipments, mainly surface longline and hand line with live sardine as bait (Pimenta *et al.*, 2007).

Cabo Frio upwelling gives to the region high fishery productivity (Moreira-Silva, 1970). The oceanographic conditions facilitate the fisherman of this fleet to catch many different species.

The aim of this paper was to characterize the multispecific small-size fleet and analyze mainly the dolphinfish, yellowfin tuna, sailfish, little tuna and another fish fishery caught by Cabo Frio small-size fleet during 2003 to 2012 period.

## 2. Material and Methods

The statistics data were monthly collected during from 2003 to 2012 at the Cabo Frio Fishing Terminal and fishery companies. The information about gear and boat size was based on interview of fishermen done by graduate student, which registered the, boat name, data, number of fish and weight by specie or group of species.

Length and weight relationship, based on total weight were used for dolphinfish, sailfish, yellowfin tuna and little tuna. The equation used for the grouped sex was as follow: dolphinfish  $W_t = 0.3 \times 10^{-5} L_t^{3.183}$  (not published); sailfish (Prager *et al.*, 1995), yellowfin tuna (Caveriviere, 1976) and little tuna (Rodriguez-Roda, 1966).

The analysis was made using the JMP Software (Version 10.0).

The small-size fishery was mainly concentrate off Cabo Frio City, Rio de Janeiro State, between the 22°S to 24°S and the 40°W to 44°W (Pimenta and Lima 2002). The collected data was based in the previous article as Pimenta *et al.* (2007).

## 3. Results and Discussion

The analysis was based on 4,276 fishery trips information of 470 small boats basically using five kinds of gears from 2003 to 2012. The gears used were surface longline (SLL), midwater longline (MLL), bottom longline (BLL), hand line (HL), bottom hand line (BHL), small purse seine (SPS), trap (TRAP), and small gillnet (SGN). The fishermen used live sardine as bait with hooks gears most of the time.

### 3.1. Characterization of small-size fleet equipments.

#### 3.1.1. Surface longline (SLL), midwater longline (MLL) and bottom longline (BLL)

The longline is a device that uses a secondary main line and several attached to a hook and swivel. The longline size and number of hooks depend of the boat size and could be used at surface, midwater or bottom according to the fishery target. It can be fixed or drift. The vessel's longline puts the box in a position to launch, spare lines, boxes with live bait, fish box, floats and others things. The launch of longlines according to boat, varies, being done by the stern or the bow.

The surface longline is released in a time immersed depending on the number of hooks used. It has no automation, so the release and hallowing is done manually.

The midwater longline is usually released on the slope with the aid of hydraulic winch.

The bottom line is released on sunrise and collected at sunset. Use about 400 circles hooks. The small fish hooked were used for the bottom longline at night.

### 3.1.2. Hand line (HL) and bottom hand line (BHL)

The hand line uses natural bait dead or alive, with one or more branch hooks. This gear is used when fishermen are looking for school of fish. Generally 6 to 8 lines per boat, according to the size and number of fishermen. The equipment consists of a nylon line of about 50 meters on their end and put a swivel with another secondary line of a nylon or steel cable to prevent loss of the hook. The fisherman catching the fish when pulls it to the side of the boat, where another fisherman with a stick pulled on board.

The bottom hand line using 6 main lines with 10 to 40 secondary lines and hooks per boat. The fishing operation is performed during the day and the equipment consists of a monofilament line followed by a swivel, attached to the monofilament line with a weight close to the hook. Along the main line are branch lines connected with swivels.

### 3.1.3. Small purse seine (SPS) and trap (TRAP)

The small purseine consists of several pieces of net without node usually braided nylon mesh from 8 to 12 mm. The approach to the school of fish is made by one side, making up the siege with the rudder to port after helping launch the boat. During the approach of the boat at the closing end of the siege, a cable is passed polyethylene board the trawler when it starts closing the enclosure. It is made at night, with the arrival in the next morning to the port and returning to fishing area in the afternoon. The sets are made close to the beach or rocky shores with a duration which varies with the amount captured from 2 to 6 hours.

The trap is suitable for catching fish and crabs and it has the form of baskets constructed with metal and surrounded by a net with an opening. The traps are placed at the bottom with bait in a single row of 10 cages away from each other by 500 meters and connected by cable to a buoy with a flag that indicates their position on the surface. The process of launching and gathering spends about one hour and the traps stay at place during the day. Complementarily during the night, the crew fish with bottom line composed of braided nylon amended the nylon monofilament by using a main line with many secondary up to 10 hooks. The small fish caught are intended to be bait for the traps on the next day.

### 3.1.4. Small gillnet (SGN)

A small gillnet consists of a rectangular net positioned vertically in the water. The target species are gilled and it usually operates in half water on the surface, drifting or anchored to the substrate. They are formed by rectangular panels of net connected end, whose length and height vary with the species to be captured. Each piece of net is mounted on two cables, with a top of the cable floats called floats and bottom weights with a number, called the cable leads. The wire cloth is soft and barely visible in the water. The small gillnet stay in the water about 12 hours, and can be placed on the surface, midwater and bottom. The launch is performed by the stern when there is no wind then they are dropped following the direction of the currents.

## 3.2. Characterization of the multispecific small-size fleet

The total production of the multispecific small fleet based in Cabo Frio City from 2003 to 2012 was 2,752 tons. The 15 top species listed in this study represented 78.7% of yield totaling 2,166 tons. The species were the dolphinfish-DOF (*Coryphaena hippurus*); bigeye tuna-BET (*Thunnus obesus*); albacore-ALB (*Thunnus alalunga*); yellowfin tuna-YFT (*Thunnus albacares*); blackfin tuna-BLF (*Thunnus atlanticus*); skipjack tuna-SKJ (*Katsuwonus pelamis*); little tuna-LTA (*Euthynnus alletteratus*); frigate tuna-FRI (*Auxis thazard*); sailfish-SAI (*Istiophorus platypterus*); swordfish-SWO (*Xiphias gladius*); white marlin-WHT (*Kajikia albida*) and blue marlin-BUM (*Makaira nigricans*); shortfin mako-SMA (*Isurus oxyrinchus*); blue shark-BSH (*Prionace glauca*); tiger shark-TIG (*Galeocerdo cuvier*).

Analyzing fleet of Cabo Frio and Angra dos Reis (RJ) with emphasis on small purse seine between 1996 and 1998, Magro *et al.* (2002) observed from registers of 8,476 landings as much higher species diversity in Cabo Frio than Angra dos Reis. Nevertheless, it was noted a decline in total production of Cabo Frio directly linked to the decline in the number of active boats, which fell from 70 in 1996 to 62 in 1997 and just 50 in 1998, totaling 138 vessels (MAGRO *et al.*, 2002). On the other hand, in the present study data were obtained from 470 boats between 2003 and 2012, involving all fishing gear but possibly showing a growing in number of small fleet in Cabo Frio.

It was observed that between 2003 to 2012 period, the main gear were surface longline-SLL, which represented 63.3% of the total weight caught and hand line-HL with 7.7% (**Figure 1**).

Based in Cabo Frio City it was observed that the small-size fleet was 61.9% occasional; 15.6% were Cabo Frio resident, 12.3% had low dependency and 10.2% had high dependency. Only about 25% remains this fleet in Cabo Frio all year round (**Figure 2**).

The boat sizes distribution was 73.6% between 11 to 15 meters long, 13.2% between 6 to 10 m, 12.4% higher than 16 m and 8% lower than 5 m (**Figure 3**).

Jablonski (1997) analyzed the multispecific fleet of Cabo Frio and Arraial do Cabo (RJ), and between the years 1985 and 1995 the production of Cabo Frio represented on average 17% of total production in the state of Rio de Janeiro. Between 1990 and 1996, the dolphinfish represented only 5% of the total catch in that period when the fleet was headed for sardines (Jablonski, 1997).

Among the species listed in the present study, the dolphinfish was the most frequently captured, totaling 1,428 t and representing 51.8% of the total yield for the whole period. The sailfish reached 250 t (9.1%), the yellowfin tuna 187 t (6.8%) and the little tuna 128 t (4.6%). The total yield by the main species is represented in **Figure 4**.

It could be observed that the dolphinfish was the target species of the fishery, however some may have directed the fleet to the sailfish. The analysis of Itaipava's fleet in southern Brazil between 2001 and 2005 showed that the dolphinfish represented 94% of the total catch from surface longline (Dallagnolo and Andrade, 2008).

The dolphinfish and sailfish were caught almost exclusively by surface longline-SLL (**Figures 5 and 6**). On the other hand yellowfin tuna was captured basically by hand line-HL (**Figure 7**). The little tuna was mostly caught by small purse seine-SPS, nevertheless also surface longline-SLL and small gillnet-SGN (**Figure 8**).

On surface longline-SLL fisheries, the main species were dolphinfish (1.408t - 80.8%) and sailfish (t 249.7 - 14.3%) (**Figure 9**). These data are very different from large scale surface longline, for example the Japanese longliners fleet in Brazil, as described by Silva (1994) from 1977 to 1991 that caught 24.7% of bigeye tuna, 20% of yellowfin and just 1% of sailfish. On the other hand, as described on the present study, according to Pimenta *et al.* (2007) the surface longline small fleet of Cabo Frio has the dolphinfish as a target species.

The most of hand line-HL captured were yellowfin tuna (161 t, 75.8%), the blackfin tuna (22.5 t, 10.6%) and also the dolphinfish (8.5 t, 4%) (**Figure 10**).

In the small purse seine the main species was little tuna (62,2 t, 68,6%), frigate tuna (22,5 t, 24,8%) and skipjack tuna (5,5 t, 6%) (**Figure 11**). Magro *et al.* (2002) studied the small purse seine fishery of Cabo Frio between 1996 and 1998 and observed that the little tuna represented just 6,7% of total capture in 1996, 6,5% in 1997 and 2,6% in 1998. The small purse seine fleet seems to have changed the target species that was sardine on the period studied by Magro *et al.* (2002).

### 3.3. Length frequency of size distribution of main species

Length classes of dolphinfish, sailfish, yellowfin tuna and little tuna were shown in **Figures 12, 13, 14 and 15**. We observed that the highest frequency of dolphinfish individuals was in the class of 100-105 cm. However, the capture of individuals smaller than 65cm was also representative. Gadoni *et al.* (2011) analyzed the dolphinfish capture off Southern Brazil between 1971 to 2010 and the most important length classes were 91-100 cm and 101-110 cm, quite similar to the present study and showing that the most frequent sizes have not changed too much since 1971. However, another important length class was from 55 to 60 cm, the smallest individuals caught between 2003-2012. According to Beardsley (1967) the size of first maturity is 42.5 cm for males and 35 cm for females from individuals from Florida. Bentivoglio (1988) described this size of 52.8 cm for males and 49-52 cm for females (Gulf of Mexico). Beardsley (1967) also observed that the size class at 100% maturity for females was 55 cm. Perez *et al.* (1992) reported the size class at 100% maturity for females from Puerto Rico as 60 cm. So that it is possible to infer that there is a high probability that the smallest dolphinfish individuals were already mature and that is why this species did not show an intense decline along the years, even catching small ones.

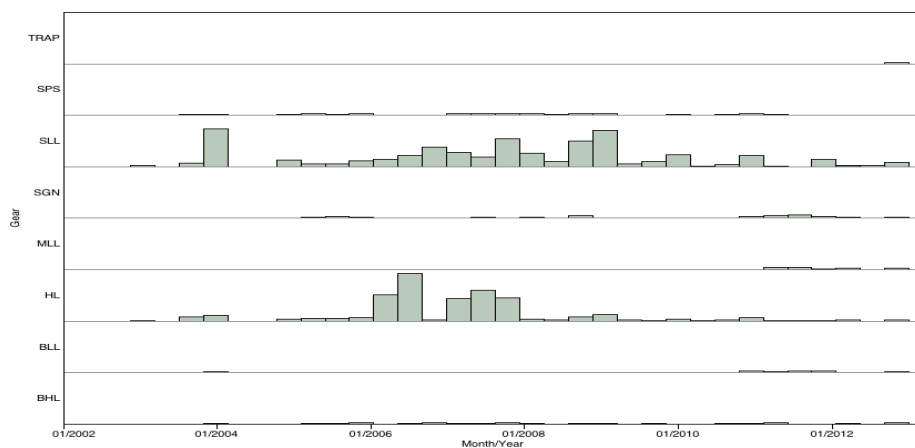
The most of specimens captured of sailfish in the period studied were from 160 to 170cm, the yellowfintuna from 110 to 120cm and little tuna had the highest frequency observed between 40 and 45cm.

**Figures 16, 17, 18 and 19** indicate the frequency of capture of different length classes of dolphinfish, sailfish, yellowfin tuna and little tuna at intervals during the period 2003-2012. The species that showed the highest

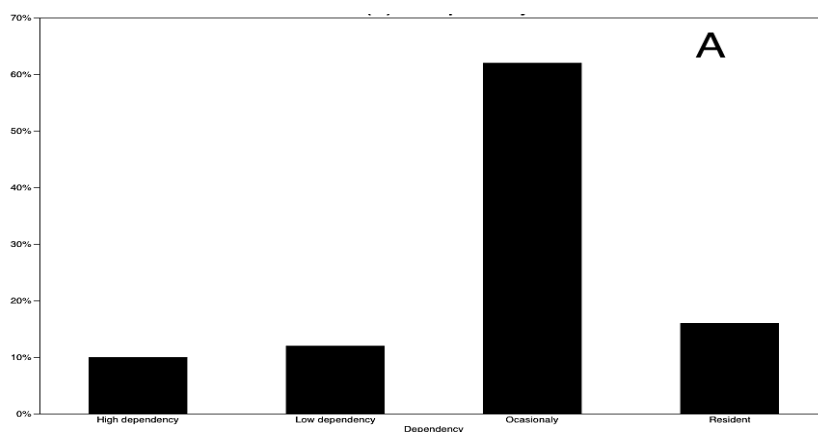
selectivity to the gear was the sailfish, which had the majority of individuals captured in the same class. The other species were captured in different length classes.

## References

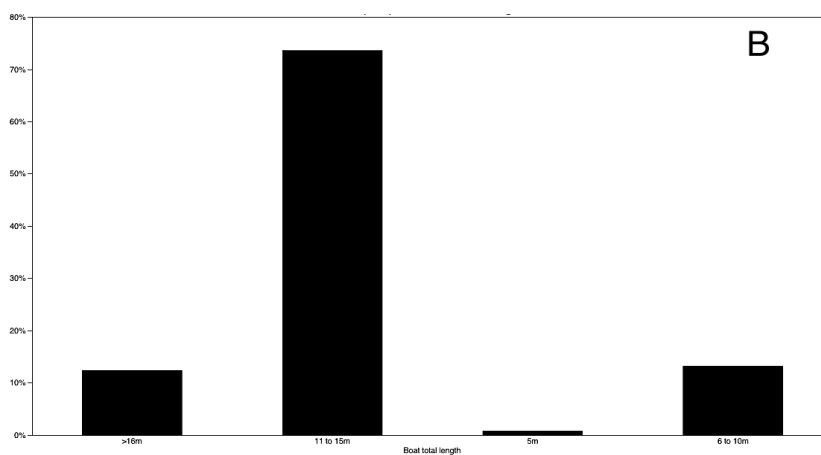
- Araújo, J.M. and Pimenta, E.G. 1995. Condicionantes socioeconômicas provenientes do movimento migratório de embarcações pesqueiras no Município de Cabo Frio - RJ. Relatório Técnico do Projeto Marlim.
- Beardsley, G.L.Jr. 1967. Age, growth and reproduction of the dolphin, *Coryphaena hippurus*, in the Straits of Florida. *Copeia*, 1967: 441-451.
- Bentivoglio, A.A. 1988. Investigations into the growth, maturity, mortality rates and occurrence of the dolphin (*Coryphaena hippurus*, Linnaeus) in the Gulf of Mexico. M.Sc. thesis, University College of North Wales, Bangor, UK. 37 pp.
- Caverivière, A. 1976. Longueur prédorsale, longueur a la fourche et poids des albacores (*Thunnus albacares*) de l'Atlantique. *Cah. ORSTOM, ser. Océanogr.*, 14(3): 201-208.
- Dallagnolo, R. and Andrade, H.A. 2008. Observações a respeito da pescaria sazonal de dourado (*Coryphaena hippurus*) com espinhel-de-superfície no Sul do Brasil. *B. Inst. Pesca, São Paulo*, 34(2): 331-335.
- Gadoni, T.B.; Fernandes, C.A.S.; Arfelli, C.A.; Pimenta, E.G.; and Amorim, A.F. 2011. Análise da captura de *Coryphaena hippurus* (Perciformes, Coryphaenidae), no Sudeste e Sul do Brasil. Resumos expandidos da 10ª Reunião Científica do Instituto de Pesca, São Paulo, 7 a 8 de dezembro de 2011.
- Jablonski, S. 1997. A pesca em Cabo Frio e Arraial do Cabo. Análise das estatísticas de desembarque. Fundação Instituto de Pesca do Estado do Rio de Janeiro – FIPERJ.
- Magro, M.; Moreira, L.H.A. and Cardoso, L.C. 2002. Estrutura e dinâmica da frota pesqueira de cerco atuante em Angra dos Reis e Cabo Frio (Rio de Janeiro - Brasil). *In: Análise das principais pescarias comerciais do Sudeste-Sul do Brasil. Vol. 1. REVIZEE – Score Sul. p.180-222.*
- Perez, R.N.; Roman, A.M. and Rivera, G.A. 1992. Investigation of the reproductive dynamics and preliminary evaluation of landings data of the dolphinfish *Coryphaena hippurus*, L. Final Report for Dingell-Johnson Project F26-1. Puerto Rico Department of Natural Resources Fishery Research Laboratory, Mayaguez, PR. 95 pp.
- Pimenta, E.G. and Marques, F.R. 2000. Diagnóstico e Implantação de Sistema Municipal de Acompanhamento do Setor Pesqueiro em Cabo Frio, COPPE/GEPESCA/UFRJ.
- Pimenta, E.G. and Lima, G. 2002. Conteúdo Estomacal de Istiophoridae e Ictiofauna acompanhante entre 1995/2002 no litoral do Estado do Rio de Janeiro. Programa de Desenvolvimento Pesqueiro/Prefeitura da Cidade de Cabo Frio&Gepesca-Gente/COPPE/UFRJ- Relatório Técnico / Data:12/02/02.
- Pimenta, E.G.; Vidal, M.; Lima, G. and Amorim, A.F. 2007. Analysis on billfish fishery off Rio de Janeiro State, Brazil (2002-03). *Col. Vol. of Sci. Pap., ICCAT, Madri*, 60 (5):1571-75.
- Prager, M.H.; Lee, D.W. and Prince, E.D. 1995. Empirical length and weight conversion equations for blue marlin, white marlin, and sailfish from the North Atlantic. *Bull. Mar. Sci.*, 56: 201-210
- Rodriguez-Roda, J. 1966. Estudio de la bacoreta, *Euthynnus alletteratus* (Raf.), bonito, *Sarda sarda* (Bloch) y melva *Auxis thazard* (Lac.), capturados por las almadrabas españolas. *Invest. Pesq.* 30: 247-92.
- Silva, J.N.A. 1994. Tuna fishery in Brazil by leased Japanese longliner fleet from 1977 to 1991. *Col. Vol. Sci. Pap. ICCAT, Madri*, 41: 180-188.



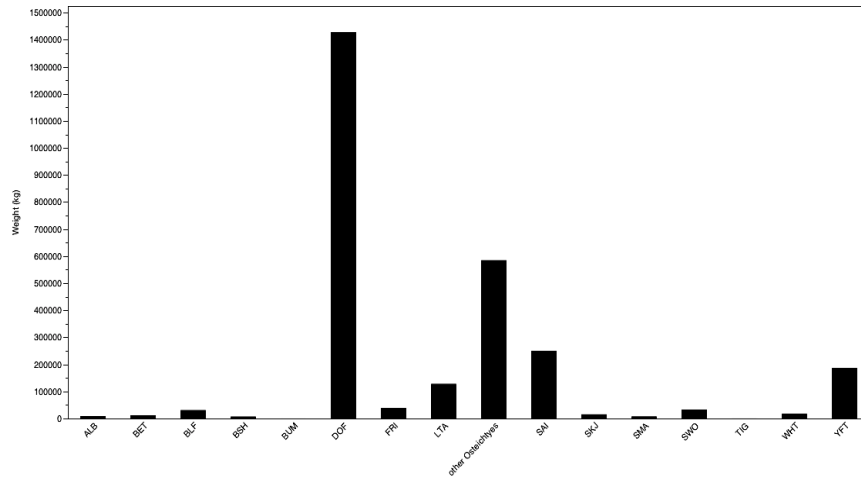
**Figure 1.** Gear composition of Cabo Frio small-size fleet: SLL (surface longline), HL (hand line), MLL (midwater longline), BLL (bottom longline), BHL (bottom hand line), SPS (small purseine), TRAP (trap), and SGN (small gillnet) from 2003-2012.



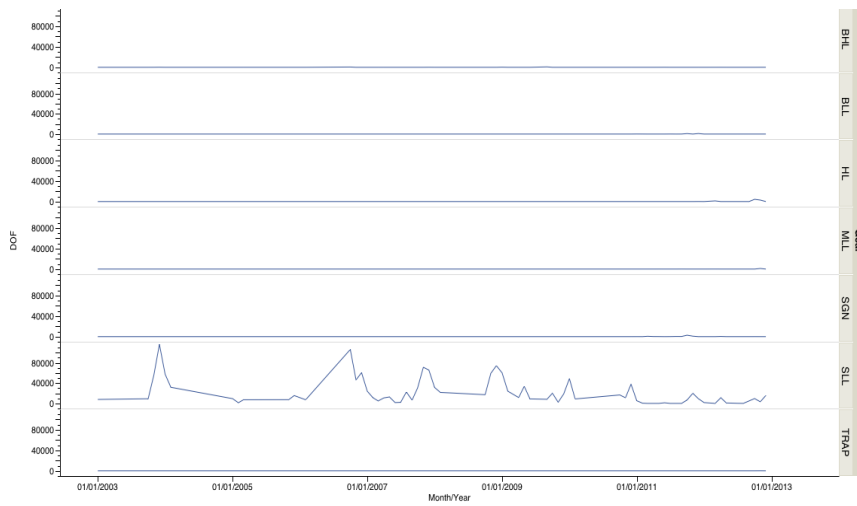
**Figure 2.** Resident dependency composition of Cabo Frio small-size fleet: high, low, occasionally and resident (2003-2012).



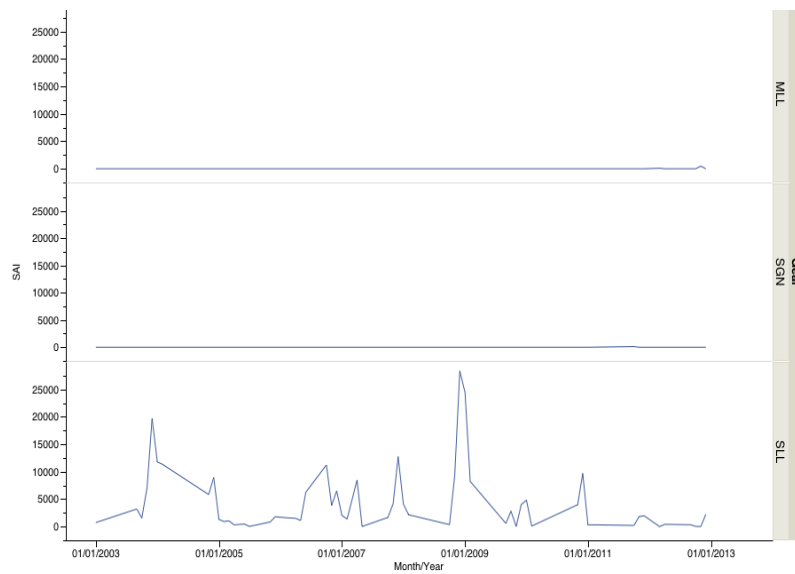
**Figure 3.** Boat size composition of Cabo Frio small-size fleet: 5 meters long, 6 to 10 m, 11 to 15 m and higher than 16 m (2003-2012).



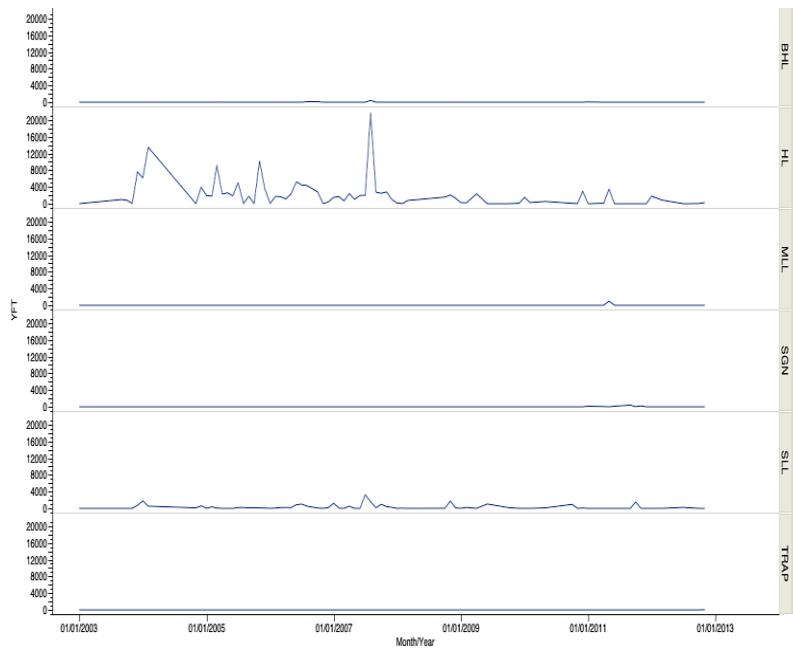
**Figure 4.** Species composition of Cabo Frio small-size fleet (2003-2012).



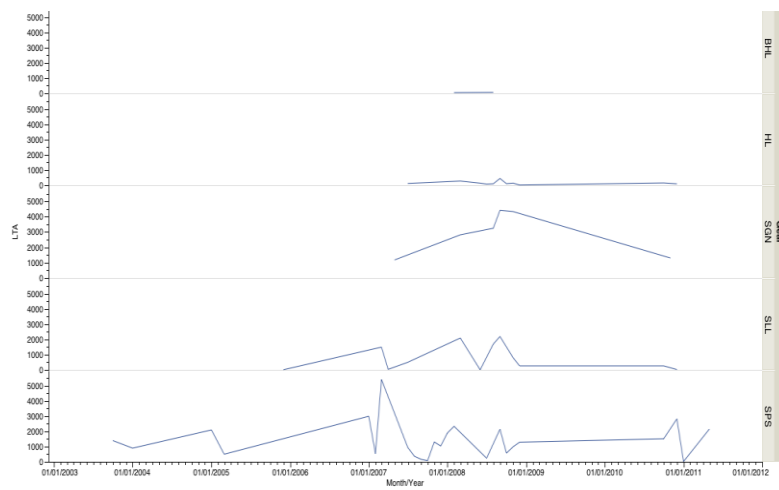
**Figure 5.** Dolphinfish weight composition by gear and year of Cabo Frio small-size fleet (2003-2012).



**Figure 6.** Sailfish weight composition by gear and year of Cabo Frio small-size fleet (2003-2012).

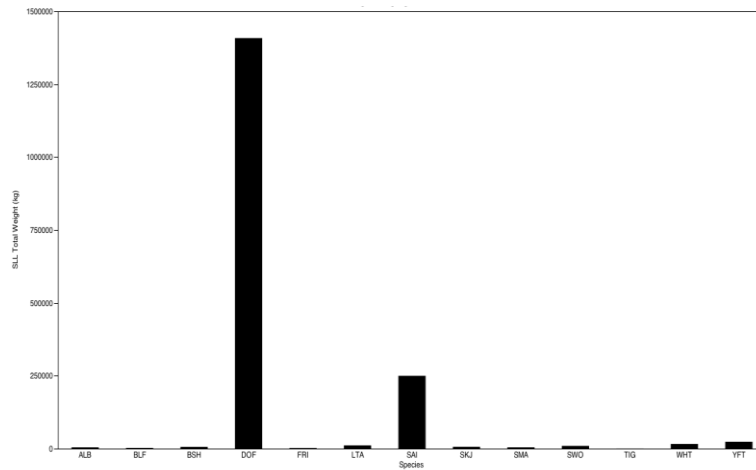


**Figure 7.** Yellowfin weight composition by gear and year of Cabo Frio small-size fleet (2003-2012).

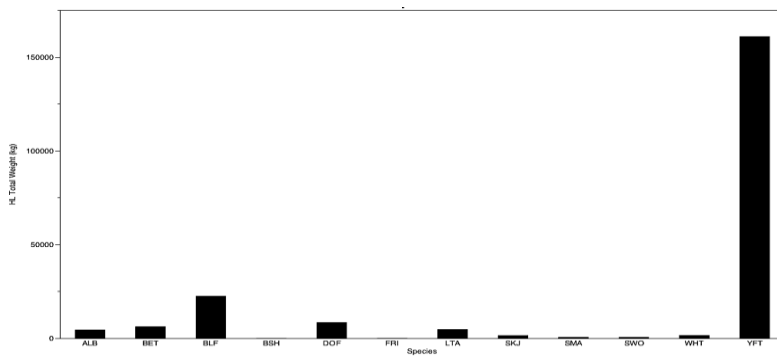


**Figure 8.** Little tuna weight composition by gear and year of Cabo Frio small-size fleet (2003-2012).

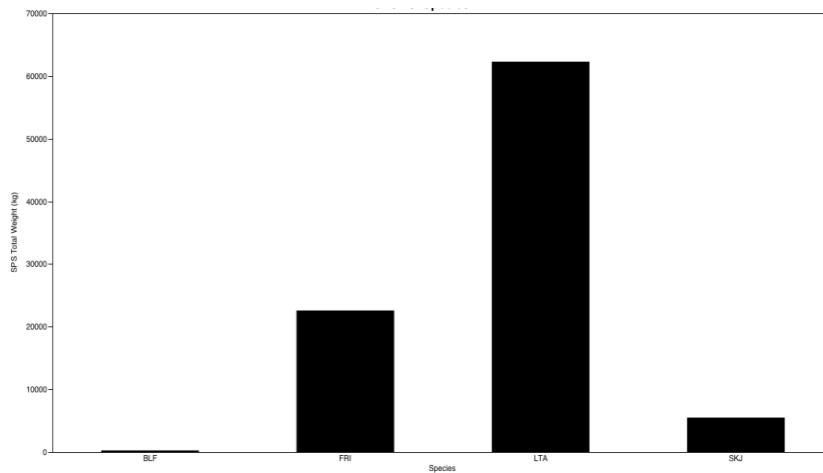




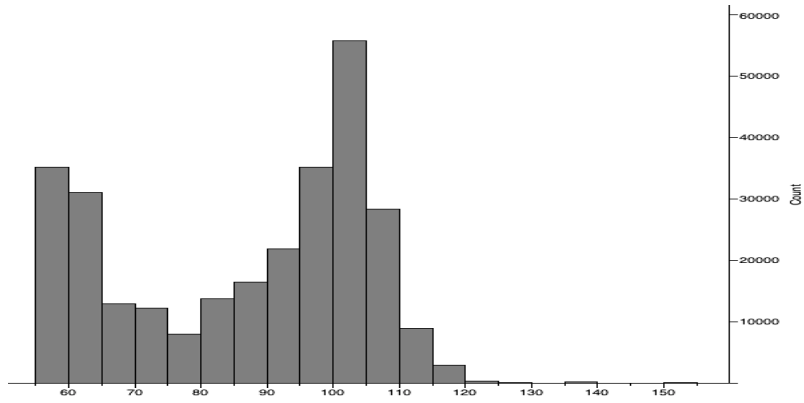
**Figure 9.** Species weight composition by surface longline-SLL of Cabo Frio small-size fleet (2003-2012).



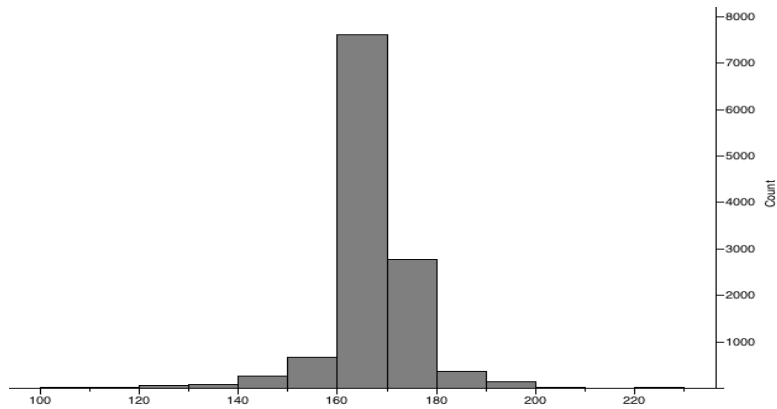
**Figure 10.** Species weight composition by surface handline-HL of Cabo Frio small-size fleet (2003-2012).



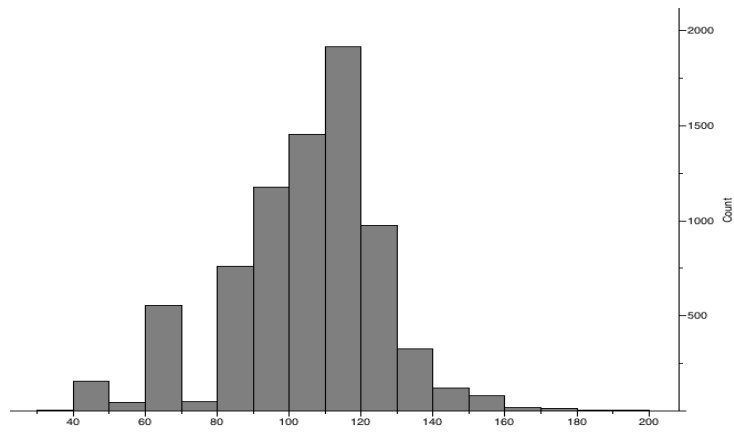
**Figure 11.** Species weight composition by small purse seine-SPS of Cabo Frio small-size fleet (2003-2012).



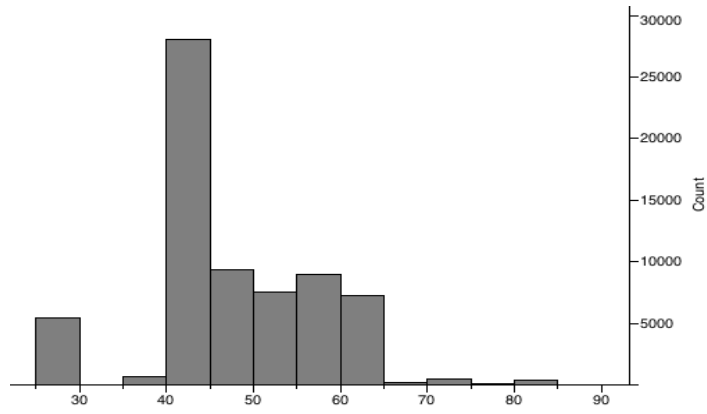
**Figure 12.** Dolphinfish weight frequency distribution (centimeters) of Cabo Frio small-size fleet (2003-2012).



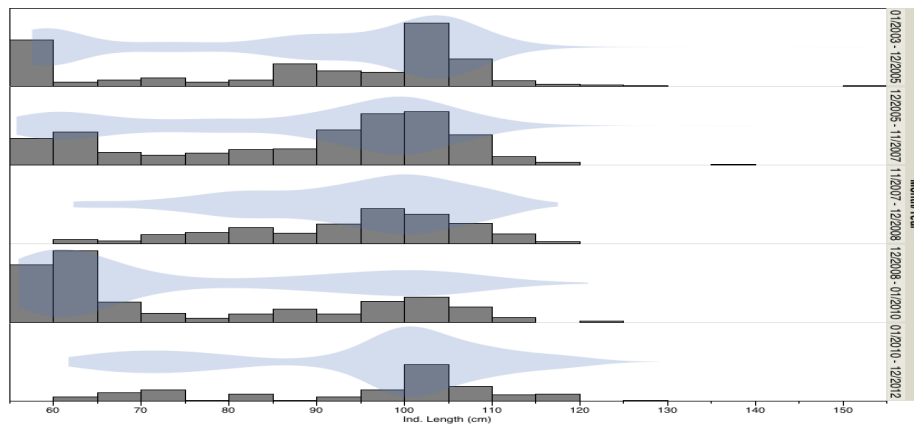
**Figure 13.** Sailfish weight frequency distribution (centimeters) of Cabo Frio small-size fleet (2003-2012).



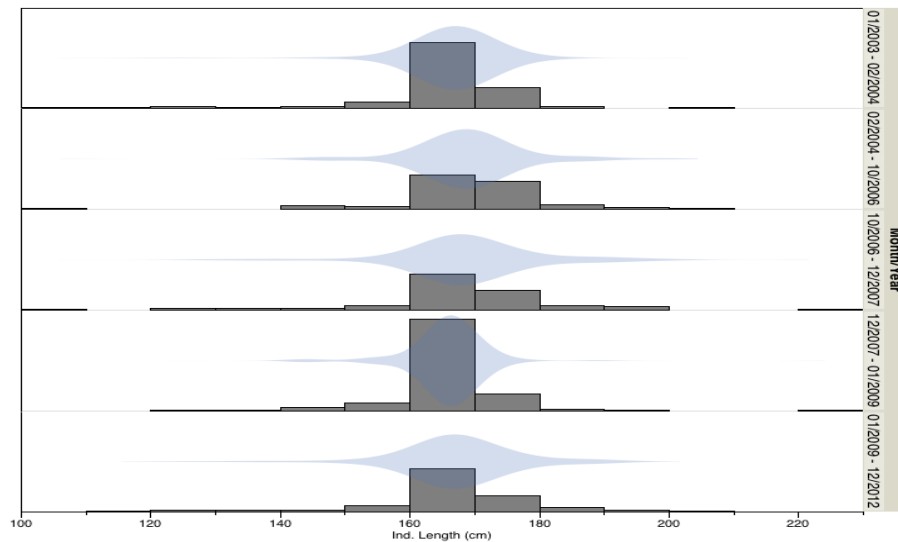
**Figure 14.** Yellow fin tuna weight frequency distribution (centimeters) of Cabo Frio small-size fleet (2003-2012).



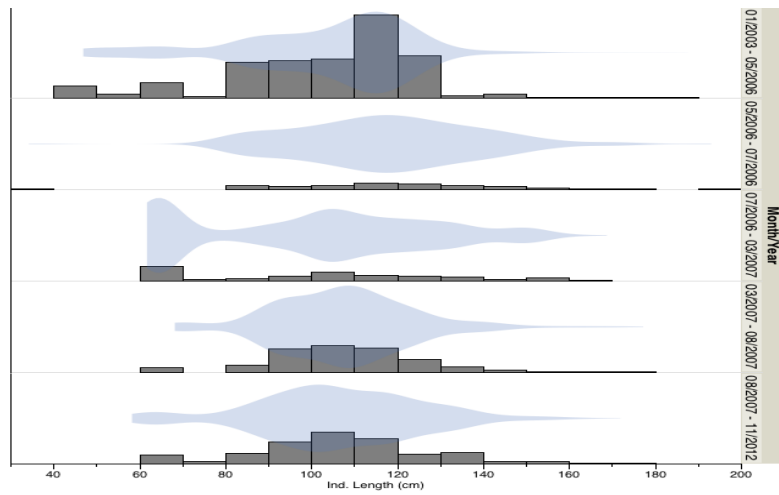
**Figure 15.** Little tuna weight frequency distribution (centimeters) of Cabo Frio small-size fleet (2003-2012).



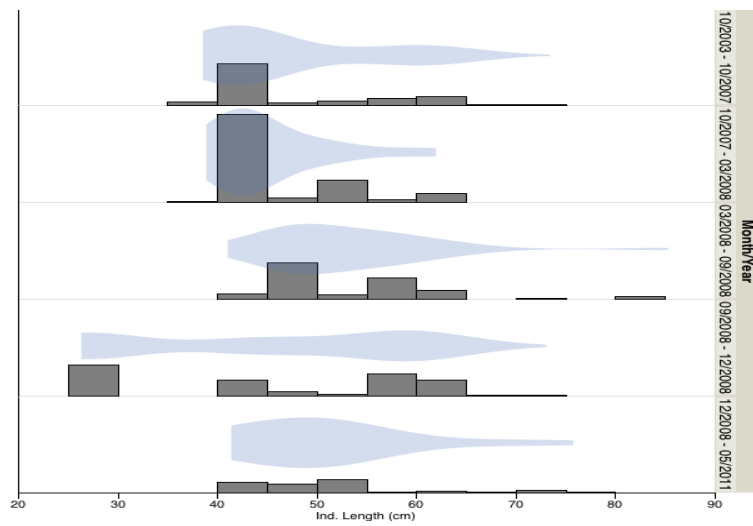
**Figure 16.** Dolphinfish length frequency distribution (centimeters) by periods of Cabo Frio small-size fleet (2003-2012).



**Figure 17.** Sailfish length frequency distribution (centimeters) by periods of Cabo Frio small-size fleet (2003-2012).



**Figure 18.** Yellowfin length frequency distribution (centimeters) by periods of Cabo Frio small-size fleet (2003-2012).



**Figure 19.** Litthe tuna length frequency distribution (centimeters) by periods of Cabo Frio small-size fleet (2003-2012).