THE TUNA FISHERIES ON 'ASSOCIATED SCHOOL' IN BRAZIL: DESCRIPTION AND TRENDS

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SUMMARY

The present work is based on catch data from the fishing fleet operating on "associated schools" of tunas, off Brazilian northeast coast, in the western Atlantic, from 2010 to 2017. The fork length (FL) of tunas was measured on board during commercial cruises and during the tagging cruises of the AOTTP/ICCAT Program. The fleet is composed actually by 227 wooden boats, ranging from 12 to 16m. The miscellaneous fishing gears are all made of polyamide monofilament and use natural or artificial baits, namely: pole and line, hand lines, and trolling. The catches are composed mainly by yellowfin tuna (67%), bigeye tuna (25%), skipjack (7%), and other species, like dolphinfish and rainbow-runner (1%). Recently this fishery became the main technique to catch tunas in Brazil, accounting for 78% of the landings. Taking into account the size at first maturity considered by ICCAT (YFT: L50= 110 cm CF; BET: L50= 105 cm CF), the 'associated school' fisheries catch mainly juveniles of both yellowfin (93%) and bigeye (97%) tunas.

RÉSUMÉ

Les présents travaux se fondent sur les données de capture de la flottille de pêche opérant sur des « bancs associés » de thonidés, au large de la côte nord-est du Brésil, dans l'Atlantique Ouest, de 2010 à 2017. La longueur à la fourche (FL) des thonidés a été mesurée à bord pendant les sorties commerciales et pendant les campagnes de marquage du programme AOTTP. La flottille est composée en réalité de 227 bateaux en bois, de 12 à 16 mètres. Les divers engins de pêche sont tous faits de monofilament de polyamide et utilisent des appâts naturels ou artificiels, à savoir : la canne et hameçon, la ligne à main et la ligne traînante. Les captures sont composées principalement d'albacore (67%), de thon obèse (25%), de listao (7%) et d'autres espèces, comme la coryphène et la carangue arc-en-ciel (1%). Récemment, cette pêcherie est devenue la principale technique de capture des thonidés au Brésil, représentant 78% des débarquements. Compte tenu de la taille à la première maturité considérée par l'ICCAT (YFT : L50= 110 cm CF ; BET : L50 = 105 cm CF), les pêcheries de « bancs associés » capturent principalement des juvéniles d'albacore (93%) et de thon obèse (97%).

RESUMEN

El presente trabajo se basa en los datos de captura de la flota pesquera que opera sobre "bancos asociados" de túnidos en aguas de la costa noreste de Brasil, en el Atlántico occidental, entre 2010 y 2017. Se midió a bordo la longitud a la horquilla (FL) de los atunes durante mareas comerciales y durante las mareas de marcado del Programa AOTTP/ICCAT. Actualmente, la flota está compuesta por 227 barcos de madera, que oscilan entre 12 y 16 m. La mezcla de artes de pesca están todos hechos de monofilamento de poliamida y utilizan cebos naturales o artificiales, a saber, cebo vivo, liñas de mano y curricán. La capturas las componen principalmente rabil (67%), patudo (25%), listado (7%) y otras especies, como dorado o macarela salmón (1%). Recientemente, esta pesquería se convirtió en la principal técnica para capturar túnidos en Brasil, respondiendo del 78% de los desembarques. Teniendo en cuenta la talla de primera madurez considerada por ICCAT (YFT: L50= 110 cm CF; BET: L50= 105 cm CF), las pesquerías de "bancos asociados" capturan principalmente rabil (93%) y patudo (97%).

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KEYWORDS

Associated school, Tuna fisheries, Hand line

1. Introduction

The tuna fishery on associated schools in Brazil began mainly in the southern region, following the deployment of fish aggregating devices (FAD), to improve the efficiency of the pole-and-line skipjack fishery with bait boat, at the boundary of the continental shelf of the states of Rio de Janeiro, São Paulo, Paraná and Santa Catarina. The FADs were always set with the aim of concentrating schools of tuna, mainly skipjack, therefore reducing the time searching for the fish at sea (Scott, 1985, Lima *et al*., 2000; Santos and Andrade, 2004). Soon after this practice began, skippers started to realize that the boat itself could work as well as a FAD and that they could keep the schools associated to the boats and thus keep fishing away from the FADs. Not only that, they also realized they could transfer the school to other boats, before moving back to port to unload their catches. Gradually, more and more boats got involved in this kind of fishing strategy, locally named as fishing in "associated school" (pesca em cardume associado) (Schroeder and Castello, 2007), quickly spreading throughout the entire Brazilian coast.

More recently, about 6 years ago, small boats (12-16 m LOA) based in Rio Grande do Norte (RN) and Ceará (CE), northeastern Brazil, and also in Espirito Santo (ES), in the southeast coast, started to target tuna schools aggregated around buoys of the PIRATA program ("Pilot Moored Array in the Tropical Atlantic"). Located in the equatorial Atlantic, these oceanographic buoys act as a FAD, aggregating a significant amount of small tunas, mainly yellowfin tunas and bigeye (Silva *et al*., 2013; Silva *et al*., 2016). Soon after this fishery started, the skippers began to employ the technique of associated schools, achieving very high productivity and therefore attracting other boat owners, resulting in a rapid increase of the fishery. The present work, therefore, aims at describing the fishing techniques and operations used in this fishery, quantifying the catches, and discussing its present status and trends.

2. Methods

This work is based on data from the fishing fleet operating on “associated schools” off Brazilian northeast coast, in the western Atlantic, from 2010 to 2017. Information on the fleet and fishing gears were compiled in the ports and by interviews with the crew and boat owners. The catch data were collected from the monitoring and research program of Universidade Federal Rural do Semiárido (UFERSA/RN), Secretary of Aquaculture and Fisheries of Ceará State (CE), Universidade Federal Rural de Pernambuco (UFRPE), and Instituto Técnico Federal de Piúma (IFES/ES).

The fork length (FL) of tunas was measured on board during commercial cruises and during the tagging cruises of the Atlantic Ocean Tropical Tunas Tagging Program of the International Commission for the Conservation of Atlantic Tuna (AOTTP/ICCAT).

3. Results and discussion

3.1 Spatio-temporal evolution of the associated school fisheries

According to the boat owners, this fishery started when longline skippers realized that there were large schools of tunas aggregated around the data buoys in the western Atlantic. The main buoy used in the beginning of this fishery is located at 000° and 035°W, which was visited by fishing boats from Areia Branca and Natal, RN. There were also reports of the use of other PIRATA buoys moored in the northern area, but in a lower intensity (**Figure 1**). However, in the middle of 2012, the introduction of the “associated school” fishing method significantly increased the productivity of this fishery, which started then to attract fishers from other localities, such as Itarema, Aracati, and Camocim, in Ceara State. The expansion of the fishing fleet also resulted in the expansion of the fishing ground, which was extended to include other buoys further north (mainly 4º, 8º, and 11ºN). More recently, from 2016 on, the fleet based at Itaipava- ES also started to use this technique off southeast Brazil, starting to visit not only the PIRATA buoys, but also several oil-drilling platforms (**Figure 1**).

3.2 The fishing fleet

The fishing fleet operating in the associated school fishery is composed mainly by wooden motorized boats, ranging from 12 to 16 m LOA, many of them adapted from the trap fishery for spiny lobsters, but also longliners and trawlers. The main adjustments done by the boats that engage in this fishery is the installation of light attractors, which are essential to promote the concentration of flying-fish, and of an insulated ice box to increase the capacity for storage and handling the catches (**Figure 2**). The crew generally is formed by 6 members, with the following roles: 1 skipper, 1 mechanic, 1 cook, 1 ice holder, and 2 auxiliary fishermen. The boats are equipped with GPS for navigation, Echo Sounder for monitoring the schools, and VHF/SSB radios for communication.

The number of boats involved in this fishery increased sharply along the years. In Areia Branca, for instance, the number of boats increased from 6, when the fishery started, to 60, in 2015, before decreasing to 50 presently. In the Ceará State, the fleet started to operate with 12 boats in 2012 and increased gradually to 127 boats, presently. More recently, this fishing activity has also spread to Espirito Santo State, starting from 10 boats, in 2016, and increasing to 50 boats, in 2017 (**Figure 3**).

3.3 Fishing Gears

Trolling is practiced *en route* to the fishing ground. Some boats use a system of rigs, while others just drag their lines from the stern. Hand-line jigging is usually practiced around the buoys or to fish the schools associated to the boats. The fishing lines are made of polyamide monofilaments at two different diameters: one with 1.8mm Ø and silicone, plastic or fiberglass lures, targeting wahoo and common dolphinfish; and the other with 1.2mm Ø and rubber bait cut in a fish shape targeting skipjack and juvenile bigeye and yellowfin tunas (**Figures 4a and 4b**).

The fishers usually use bamboo poles to fish. There are two kinds of bamboo poles: the short one and the long one. The short pole has about 2.7m in length and 3cm in diameter, equipped with polyamide monofilament 1.6mm Ø, usually attached to barbless or J-type hooks baited with raffia or silicone lure. The long one has approximately 4.5m in length and is divided into two sections, both made of polyamide monofilament, one with 1.8mm Ø and the other with 1.6mm Ø, ending in a J-type hook baited with silicone lure. At the tip of the pole there is a slit through which passes the line, remaining free until such time as it starts being hand-operated by the fishers. These techniques are more efficient during daytime, with the boat moving upwind at an average speed of 2-knots and catch mostly juveniles of bigeye and yellowfin tunas (**Figures 4c and 4d**).

The hand-lines are made of polyamide monofilament ranging from 1.2 to 2.5mm Ø, according to the target species. They carry J-type hooks or triple-type ones. As auxiliary gear, gaffs and harpoons are also used for hauling the larger specimens onto the deck. During daylight, catching is performed either with the boat moving upwind at an average speed of 2-knots, while fishing for juvenile yellowfin and bigeye tuna, or drifting, while fishing for common dolphinfish, with strips of fish as bait, or larger specimens of yellowfin tuna and blue marlin with live skipjack or juvenile tunas as bait.

During the night, fishermen usually catch flying-fishes first, with dipnets, after attracting them by turning on the lights around the boat, and then use them as a live bait targeting adult yellowfin. (**Figure 4e and 4f**).

A local version of the handline named “boleado” is comprised of three sections of polyamide monofilament: the first one with 180m and 1.8mm Ø; the second one, with only 0.45m and 3mm Ø, with one sinker that is released during the hauling if some fish is caught, and the third and final one, with 20m and 1.2mm Ø. This technique is directed to deeper zones, being usually operated at night to catch mainly bigeye tuna.

3.4 Catch composition and trends

There were 5 landing points at Areia Branca- RN, which accounted for 21% of the ‘associated school’ fisheries in 2017. In Ceará, the main landing points are concentrated in Itarema, but there also reports of landings in Camocim, Acarau, and Aracati. Together, these Ceará ports accounted for 67% of the catches in 2017. In the Espirito Santo, the main landing point is located at Itaipava, which accounted for 24% of the catches in 2017 (**Figure 5**).

The catches are composed mainly by yellowfin tuna, bigeye tuna, and skipjack, but other species, like dolphinfish and rainbow-runner (1%) are also caught. The annual variation by species shows a stable trend with the participation of yellowfin tuna ranging from 69 to 72%, bigeye tuna ranging from 24 to 28%, and skipjack ranging from 2 to 4%. The total catch of all the threes species of tunas caught has been increasing since the beginning of the fishery, with yellowfin tuna showing the sharpest growth (**Figure 6**).

From 2010 to 2012, at the beginning of this fishery, its participation in the catches of yellowfin, bigeye, and skipjack in Brazil increased from 2 to 31%, while the main techniques responsible for the catches of these tuna species were still the longline and, to a less extent, the pole and line with live bait, accounting together to 65% of the landings. Gradually, and particularly with the introduction of the fishing technique on associated schools, the participation of this fishery in the national landings of yellowfin tuna and bigeye increased to 78%, in 2016, with the participation of longline and pole and line decreasing to only 21% (**Table 1; Figure 7**).

3.5 Size composition

Taking into account the size at first maturity considered by ICCAT (2018 YFT: L50= 110 cm CF; BET: L50= 105 cm CF), the 'associated school' fisheries catch mainly juveniles of both yellowfin (93%) and bigeye (97%) tunas. Almost 90% of BET catches were from classes 40-80 cm FL, while 80% of YFT catches were from classes 40-70 cm FL (**Figure 8**).

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Table 1. Brazilian landings (t live) of yellowfin, bigeye, and skipjack by fisihing gear and year: Bait Boat – BB; Handline – HAND; Longline – LL; Surface Longline – LLsurf; Purse Seine – PS; and Unknown/No specified – UNCL.

Year	BB	HAND	LL	LL-surf	PS	UNCL	Total
2010	724	83	2.194	-	-	1.849,8	4.850
2011	1.418	624	3.230	-	7	175,7	5.455
2012	911	2.124	3.373	44	1	335,8	6.789
2013	1.163	7.220	2.240	278	-	-	10.901
2014	277	14.746	2.855	223	-	-	18.101
2015	493	17.089	3.435	881	-	1.762,0	23.660
2016	447	18.994	4.654	246	-	-	24.342
Total	5.432	60.881	21.981	1.673	9	4.123	94.099

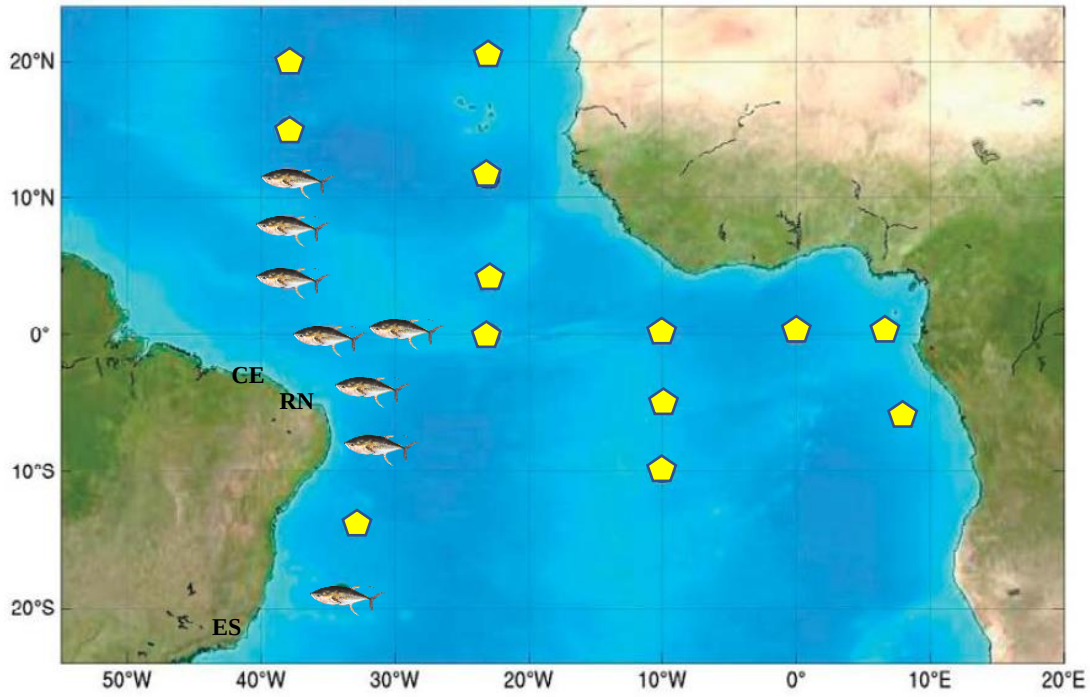

Figure 1. Location of the PIRATA buoy array (yellow) in the Atlantic and the main States in Brazil (CE, RN and ES) where the fleet is based. Buoys with interaction with fisheries are marked with tunas (Adapted from Bourlés *et al.*, 2008).

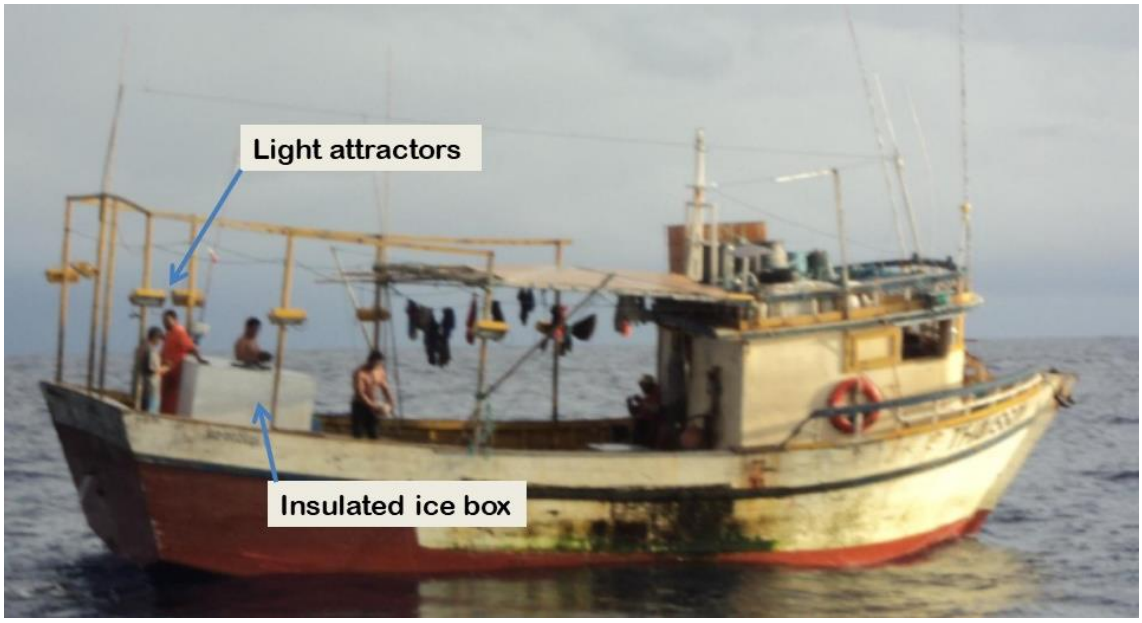

Figure 2. Features of a typical boat operating in the associated school fisheries in the western Atlantic, with indication of the main adjustments done to adapt the boat to this fishing activity.

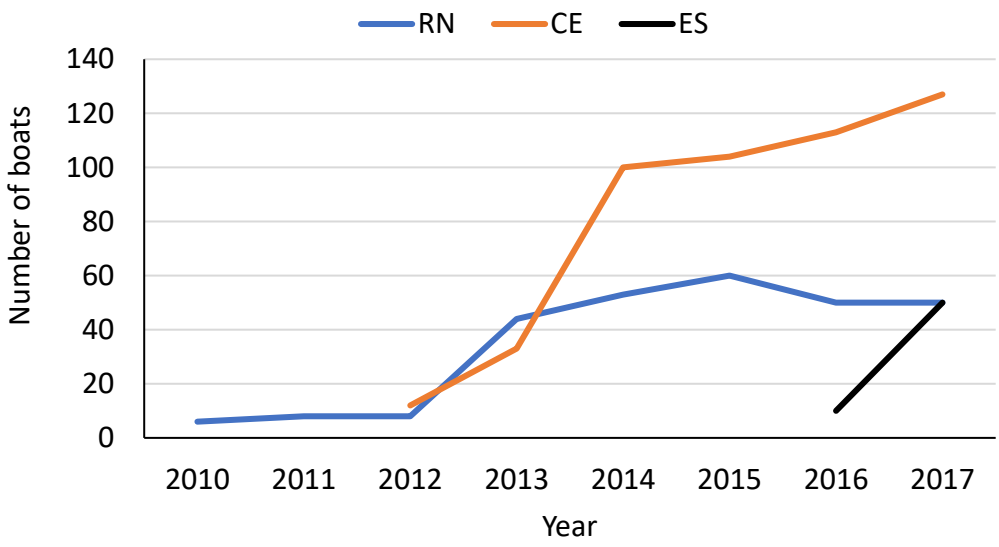

Figure 3. Temporal evolution of the number of boats operating in the associated school fisheries in Brazil.

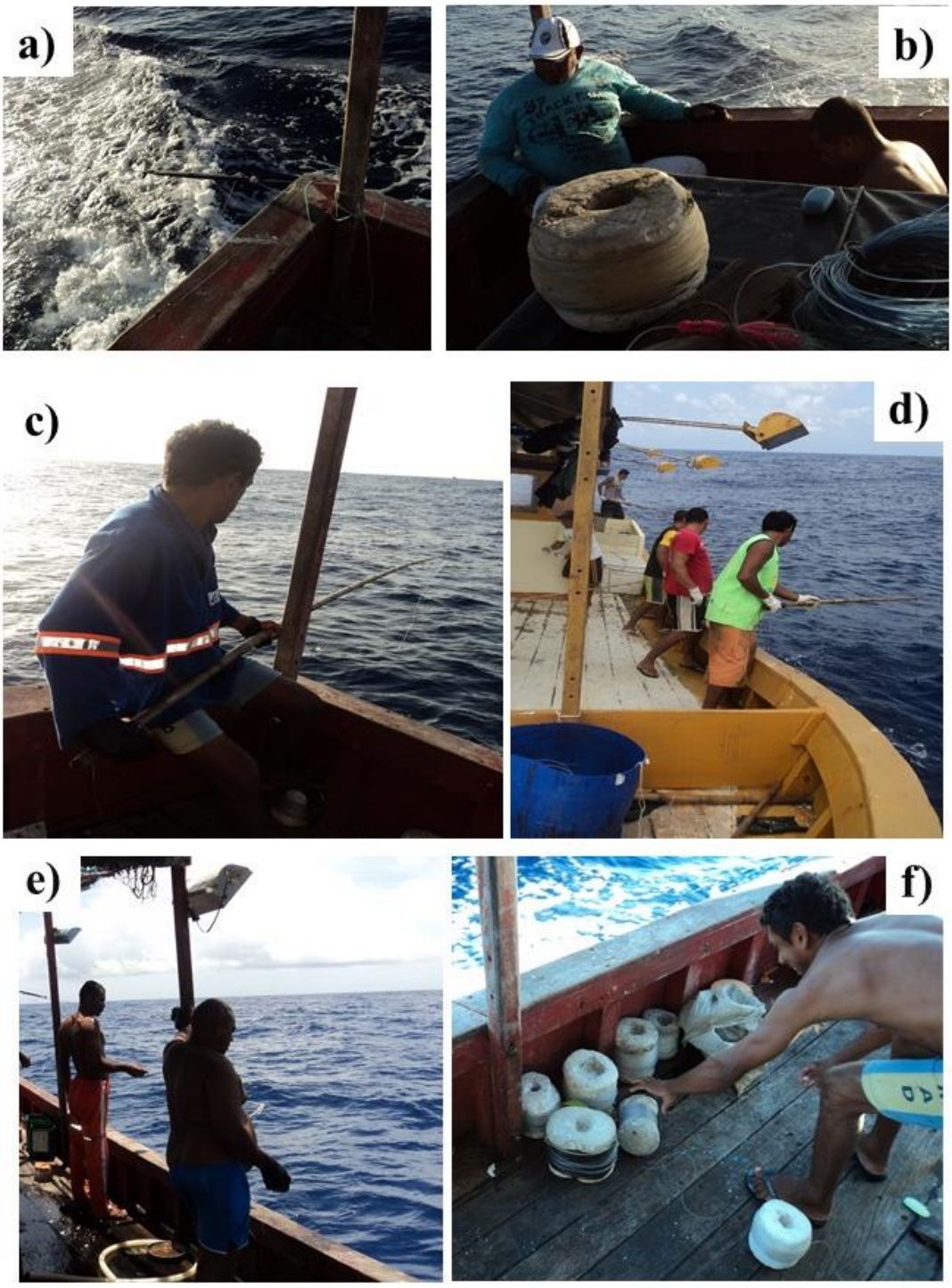

Figure 4. Main fishing gears utilized in the ‘associated school’ fisheries in Brazil: a) Trolling; b) Jigging; c and d) Pole and line; e and f) Handlines.

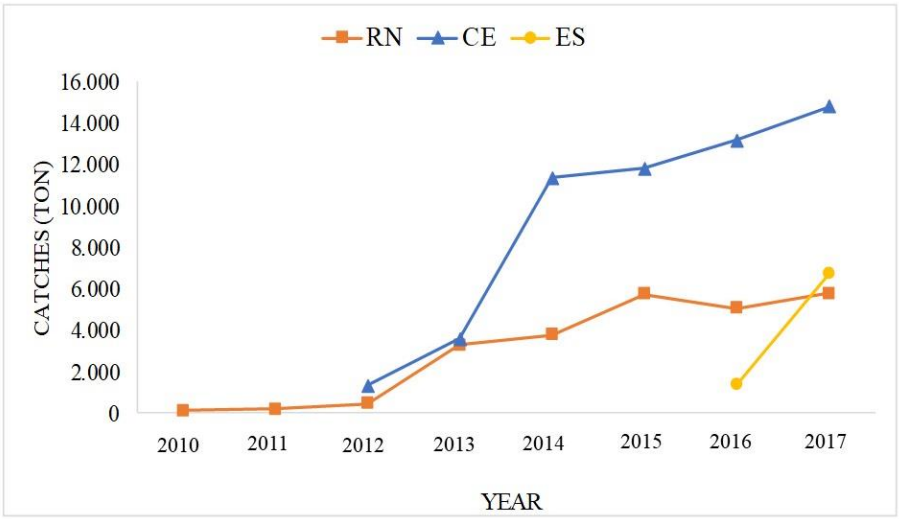

Figure 5. Annual catches (t) in live weight for yellowfin, bigeye, and skipjack from fisheries on associated schools by Brazilian States (Rio Grande do Norte – RN; Ceará – CE; and Espirito Santo – ES).

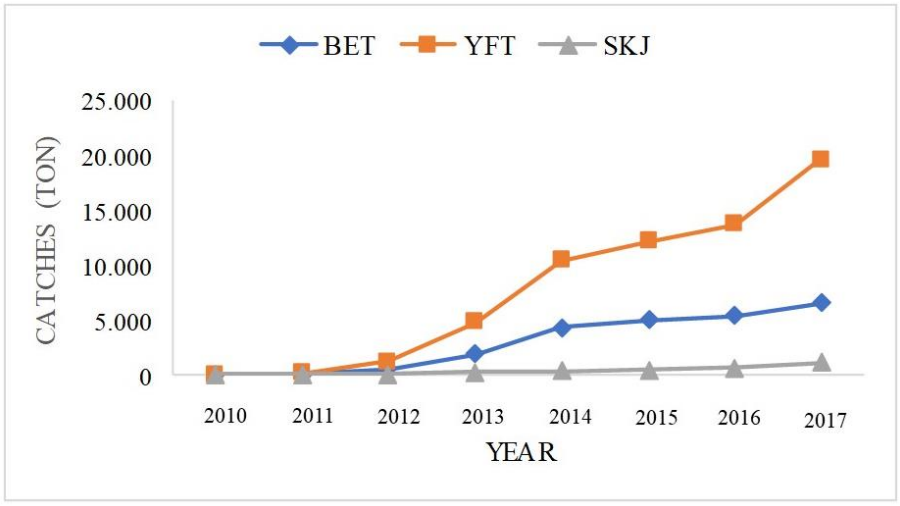

Figure 6. Annual variation in the catches (t) in live weight from yellowfin (YFT), bigeye (BET), and skipjack (SKJ) from fisheries on associated schools off Brazil.

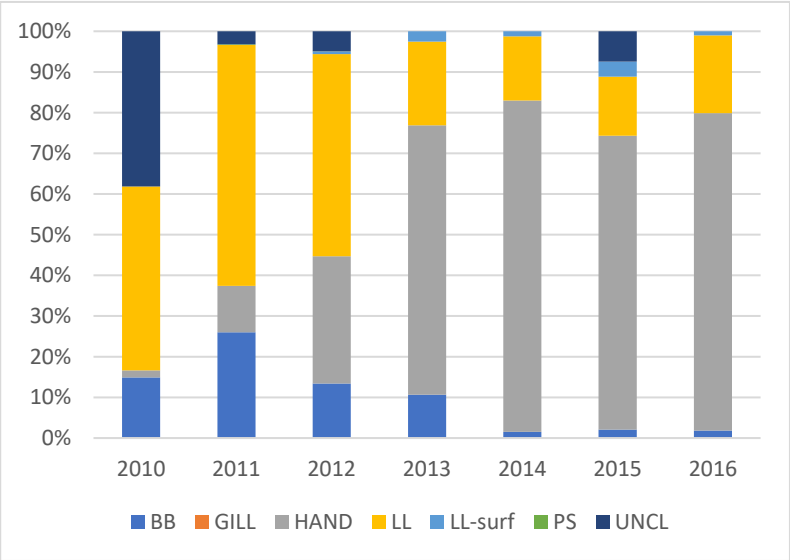

Figure 7. Relative participation in the landings (t live) of yellowfin, bigeye, and skipjack by fishing gear and year: Bait Boat – BB; Handline – HAND; Longline – LL; Surface Longline – LLsurf; Purse Seine – PS; and Unknown/No specified – UNCL.

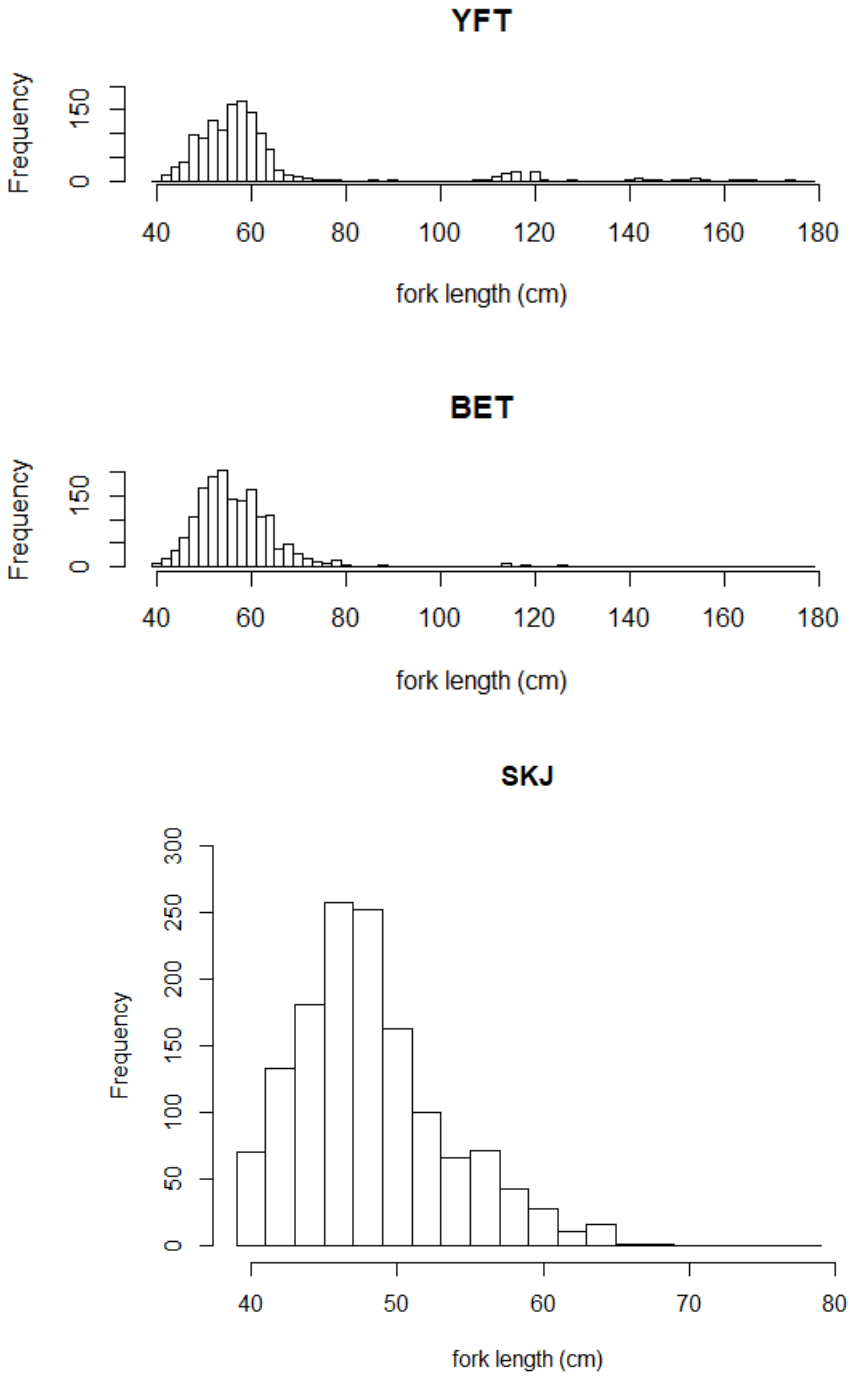

Figure 8. Size distribution of main tuna species (yellowfin tuna-YFT; bigeye tuna-BET; and skipjack-SKJ) caught in the 'associated school' fisheries, from 2010 to 2017.