WHAT CAN THE SIZE DATA TELL US ABOUT THE WESTERN ATLANTIC SKIPJACK TUNA STOCK?

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SUMMARY

More than 75% of the total catches of the western Atlantic skipjack tuna stock are performed by the baitboat fishery along the south and southeastern Brazil. This fishery has been well sampled but occurs in a restricted area concerning the entire stock distribution preventing a comprehensive analysis of the fish size's spatial distribution. However, a vast dataset on spatially distributed size samples (> 7 million measured fish) provided an opportunity to analyze the spatial distribution of skipjack sizes across the western Atlantic. Overall, the larger mean sizes occurred inside and a little further north and south of the tropical latitudes, from 30ºN to 30ºS. The smaller mean sizes were observed in areas closer to the coast and at higher latitudes in the southern and northern hemispheres. The different fishing gears seem to present different selectivities since the length composition from the purse seine showed the smaller individuals than the baitboat fishery, while the longline catches the larger ones.

RÉSUMÉ

Plus de 75% des captures totales du stock de thon listao de l'Atlantique Ouest sont réalisées par la pêcherie de canneurs le long du Sud et du Sud-Est du Brésil. Cette pêcherie a été bien échantillonnée mais elle a lieu dans une zone restreinte concernant l'ensemble de la distribution du stock, ce qui empêche une analyse complète de la distribution spatiale de la taille du poisson. Cependant, un vaste jeu de données sur des échantillons de taille spatialement distribués (> 7 millions de poissons mesurés) a permis d'analyser la distribution spatiale des tailles du listao dans l'Atlantique Ouest. Dans l'ensemble, les tailles moyennes les plus grandes ont été observées à l'intérieur et un peu plus au Nord et au Sud des latitudes tropicales, de 30ºN à 30ºS. Les tailles moyennes les plus petites ont été observées dans les zones plus proches des côtes et à des latitudes plus élevées dans les hémisphères Sud et Nord. Les différents engins de pêche semblent présenter des sélectivités différentes puisque la composition par taille de la senne montrait des spécimens plus petits que la pêcherie de canneurs, alors que la palangre capture les plus grands.

RESUMEN

Más del 75 % de las capturas totales del stock de listado del Atlántico occidental son realizadas por la pesquería de cebo vivo a lo largo del sur y sudeste de Brasil. Esta pesquería ha sido bien muestreada, pero se produce en un área restringida en relación con la distribución de todo el stock, lo que impide un análisis exhaustivo de la distribución espacial de las tallas de los peces. Sin embargo, un gran conjunto de datos sobre muestras de tallas distribuidas espacialmente (> 7 millones de peces medidos) ofreció la oportunidad de analizar la distribución espacial de las tallas del listado en el Atlántico occidental. En general, las tallas medias más grandes se produjeron mar adentro y un poco más al norte y al sur de las latitudes tropicales, desde 30ºN hasta 30ºS. Las tallas medias más pequeñas se observaron en las zonas más cercanas a la costa y en las latitudes más altas de los hemisferios sur y norte. Los diferentes artes de pesca parecen presentar diferentes selectividades, ya que la composición de tallas de la pesquería de cerco mostró ejemplares más pequeños que la pesquería de cebo, mientras que el palangre captura los más grandes.

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KEYWORDS

Size-data, Fishing gears, SW Atlantic, Skipjack tuna

1. Introduction

The Standing Committee on Research and Statistics (SCRS) of the International Commission for the Conservation of Atlantic Tunas (ICCAT) has historically considered the existence of two distinct stocks of skipjack tuna (*Katsuwonus pelamis*) in the Atlantic Ocean (eastern and western). The western stock has been mainly caught by Brazil and Venezuela, which together have accounted for 97% of the catches, on average, in the past 10 years (2009-2018). Brazil has caught on average 90% (ranging from 82.6 to 94.4), and Venezuela 7% (4.5-10.5%).

The Brazilian skipjack fishery operates with two different fishing methods: pole-and-line with live bait (baitboat), in the south and southeast region, and more recently handline in associated schools, off the northeast region. The pole and line fishery started in the early 80s and increased very quickly both in terms of number of boats and in landings (Castello and Habiaga, 1989). Throughout the past 25 years, the landed weight has ranged from 16,560 tonnes (t) in 1995, to 32,438 t in 2013, with an average catch of 23,238 t. The fluctuation of yearly catches, however, is often attributed to changes in stock availability due to oceanographic conditions (Matsuura and Andrade, 2000) and to live bait availability (Santos and Rodrigues Ribeiro, 2000) rather than to changes in stock abundance. The fishing ground spans from the southern boundary of the Brazilian EEZ (34ºS), to the coast of Rio de Janeiro (22ºS), with the main fishing season happening from late spring (November-December) to autumn (April-May). Another fishery that has been catching increasing quantities of skipjack tunas is the handline fishery in associated schools (Silva et al., 2018), happening mainly off the northeast coast of Brazil. This fishery started in 2009 and grew rapidly, but its main targets have always been yellowfin tuna and bigeye tuna. In 2019, the SKJ catches by this fishing gear was about 2,000 t, while the baitboat fishery landed about 15,000 t.

The western skipjack has also been caught by other fishing fleets, like purse seine, longlines, rod & reel, and troll, but in minimal quantities. In the last five years, the purse seine skipjack catches comprised on average 12% of total catches, while the longline, on average, 2% of the total, the rod & reel, and troll comprised together 2% of the total catches. Despite the small participation in the yields, the size data from these fishing fleets could help understand the spatial size distribution along the western Atlantic since the fishing grounds of the bait boat and handline fisheries are restricted from south to southeastern, and in northeastern Brazil, respectively.

During the last five years, two projects sampled a vast amount (> 65,000 individuals) of skipjack in the western Atlantic Ocean. The “Skipjack Tuna Project: ecology and socioeconomics of *Katsuwonus pelamis* fishing off the coast of Rio de Janeiro aiming at stock assessment, sustainable management and its use in school feeding” sampled the bait boat fishery from the south to southeastern Brazil from 2017 to 2018 (Madureira and Monteiro-Neto, 2020). The “Atlantic Ocean Tropical Tuna Tagging Program (AOTTP)” sampled several tuna species by diverse fishing fleets from 2016 to 2020 throughout the Atlantic. These size samples combined with the ICCAT Task 2 database (> 7 million fish) covering the time period from 1970 to 2020 provided an opportunity to analyze the spatial distribution of skipjack sizes across the western Atlantic.

2. Methods

2.1 Size data

Size data from the western stock of Skipjack tuna were gathered from a variety of information sources, between 1970 and 2020, including:

- the ICCAT Task 2 database (1970-2020),
- the “Atlantic Ocean Tropical tuna tagging Program (AOTTP)” database (2016-2020),
- the “Skipjack Tuna Project” database (2016-2018).

All data were dated, georeferenced, and grouped into a unified dataset. Mean sizes (Fork length (cm)) were displayed into latitudinal intervals (from 45°N to 35°S, at 5° interval) by gear, quarter and decade, as part of its descriptive analysis. The size distributions and the mean size by year were presented for each gear to analyze possible trends in the mean size along time.

All analysis were conducted using the R software (R Core Team 2021), and the “ggplot2”, “tmaptools”, “rgeos”, “rgdal”, and the “cowplot” packages were used to generate figures and maps.

3. Results

3.1 Data availability

Size data of more than 7 million skipjack tuna (**Table 1**) sampled from five fishing gears between 1970 and 2018 were analyzed. The sampling covers a wide area of the of skipjack distribution in the Western Atlantic Ocean (**Figure 1**). The more intensive sampled areas are southern Brazil and the areas in front of the Guiana and at the northwestern coast of Venezuela (**Figure 1**). The less sampled area was the southwestern North Atlantic Ocean.

3.2 Size distribution by gear

The gear that covered the widest sampling distribution area was the longline (LL), from which it is possible to observe that the larger fish (> 70 cm FL) are distributed within and a little further north and south of the tropical latitudes, from 30ºN to 30ºS (**Figure 2**) and in higher distances from the coast. This may be resulting from the gear selectivity as the LL catches larger fish than the other fishing gears (**Figure 3**). However, the other fishing gears didn’t fish in the same location of the LL; thus, further studies are necessary to elucidate if the larger skipjack occurs at lower latitudes and in high seas.

The bait boat (BB) fishery data covered an area close to the coast. They showed an opposite trend, with smaller mean sizes in lower latitudes, except for two quadrants in the southeastern Brazilian coast **(Figure 1**), where larger mean sizes were sampled. The data from the other fishing gears (purse seine (PS), handline (HL), rood & reel (RR), Sportive fisheries (SPOR), and unidentified fishing gear (UN)) was more fragmented in the distribution range, which limits the analysis of latitudinal trends.

3.3 Size distribution by quarter

When analyzing the size distribution by quarter, it is possible to observe that the larger mean sizes were within and a little further north and south of the tropical latitudes throughout the year. The larger fish were closer to the coast in the first quarter of the year and more distant in the second and third quarters (**Figure 4**).

3.4 Size distribution by decade

The 2000s and 2010s decades were the best sampled periods (**Figure 5**), and the 2010s presented the widest coverage sampling area. In both decades (2000’s and 2010’s), it was possible to observe the same pattern in the western South Atlantic, in which larger mean sizes were sampled in northeastern Brazil while smaller mean sizes were observed in southeastern and southern Brazil. However, in both decades, it was also observed small mean sizes in the northern portion of northeastern Brazil (**Figure 5**), resulting from the purse seine sampling in that area (**Figure 2**) since the purse seine retains smaller individuals than the other gears (**Figure 3**).

No apparent pattern emerges from the analysis of the long-term yearly mean sizes for the main fishing gears catching the Skipjack tuna in the western Atlantic (**Figure 6**). The mean size of the baitboat catches declined in the last years, but this decline can be observed in other periods along with the time series, for example, during the early 1970s and the early 1990s. The time series for the other fleets showed a dynamic pattern through time with sizes above and below the overall mean size (55.6 cm) (**Figure 6**).

References

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Table 1. Number of Skipjack measured and mean sizes from five fishing gears between 1970 and 2018 by decade in the Western Atlantic Ocean. From each decade it is presented the total number of fish sampled (N), and the mean size (Mean).

Gear	Year												Total	
	1970		1980		1990		2000		2010		2020			
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
Bait boat			406,950	55.2	155,149	53.4	241,053	53.5	39,757	51.3	36	60.8	842,945	53.7
Handline									5,688	49.2			5,688	49.2
Longline	1	54.0	27	56.6	400	56.4	169	81.6	13,525	68.3	1,057	60.8	15,179	67.1
Purse seine	869	56.2	2,022,210	51.3	3,855,715	48.3	402,061	48.1	26,258	47.7	1,202	54.2	6,308,315	49.1
Rood & reel							134	53.4	12	45.3			146	52.6
Sportive									79	49.8			79	49.8
Unidentified			1,465	54.9			64	62.3					1,529	57.9
Total	**870**	**56.0**	**2,430,652**	**54.4**	**4,011,264**	**52.0**	**643,481**	**54.1**	**85,319**	**58.3**	**2,295**	**59.5**	**7,173,881**	**55.6**

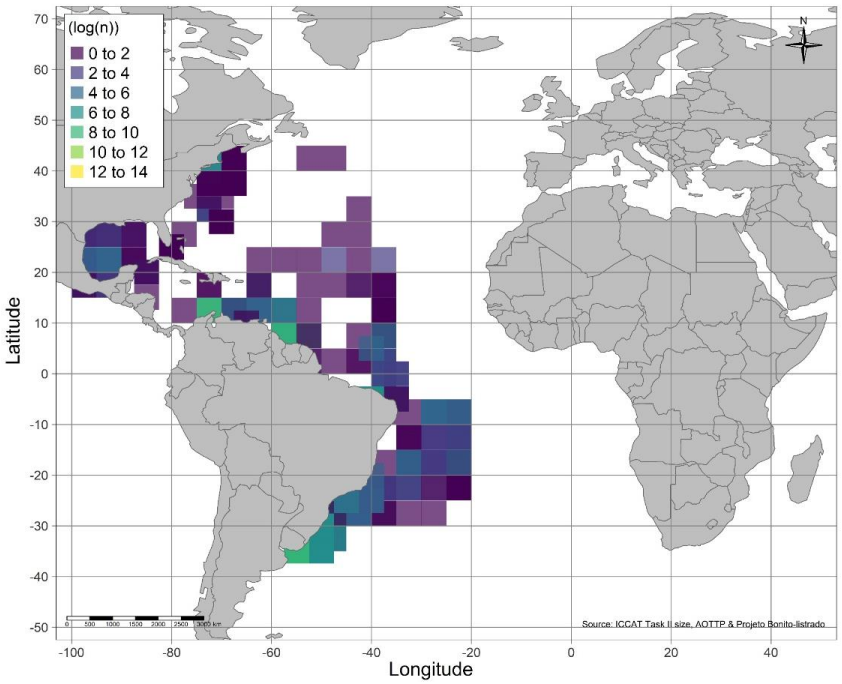

Figure 1. Logarithm of the number of Skipjack fish sampled along the Western Atlantic Ocean within 5°x5° quadrants from 1970 to 2020.

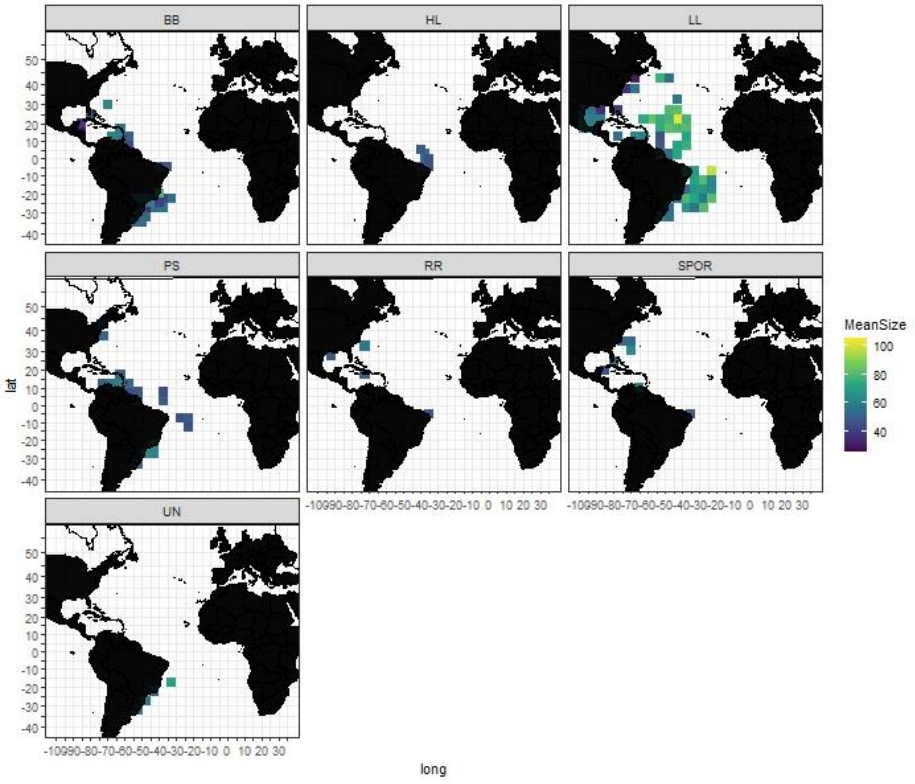

Figure 2. Mean size of Skipjack tuna from the western Atlantic within 5°x5° quadrants sampled from different fishing gears from 1970 to 2018. LL: longline, BB: bait boat, PS: purse seine, HL: handline, RR: rood & reel, SPOR: sportive fisheries, UN: unidentified fishing gear.

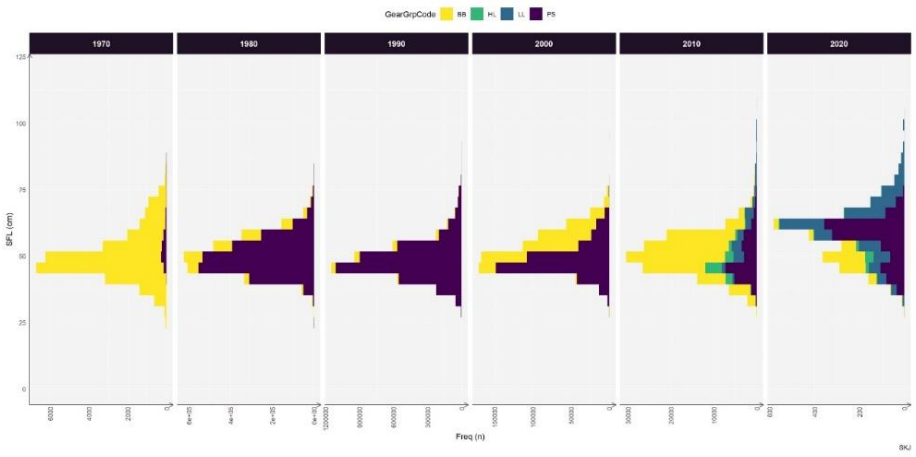

Figure 3. Size compositions of Skipjack tuna from the western Atlantic by decade and fishing gear. LL: longline, BB: baitboat, PS: purse seine, HL: handline, RR: rood & reel, SPOR: sportive fisheries, UN: unidentified fishing gear.

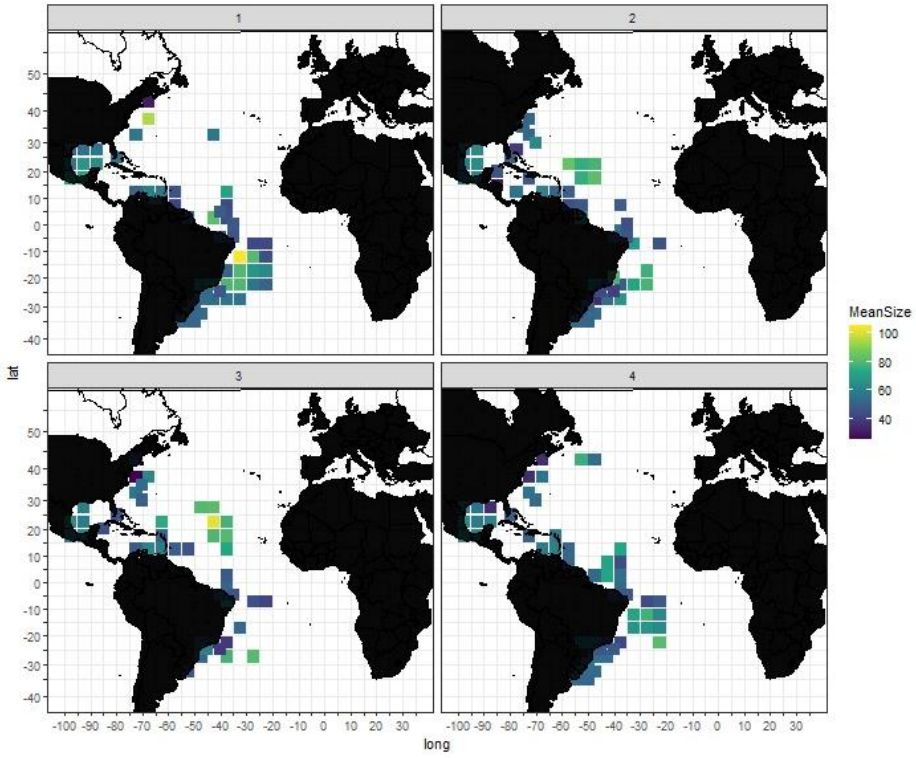

Figure 4. Mean size of Skipjack tuna from the western Atlantic within 5°x5° quadrants sampled in different quarters of the year from 1970 to 2018.

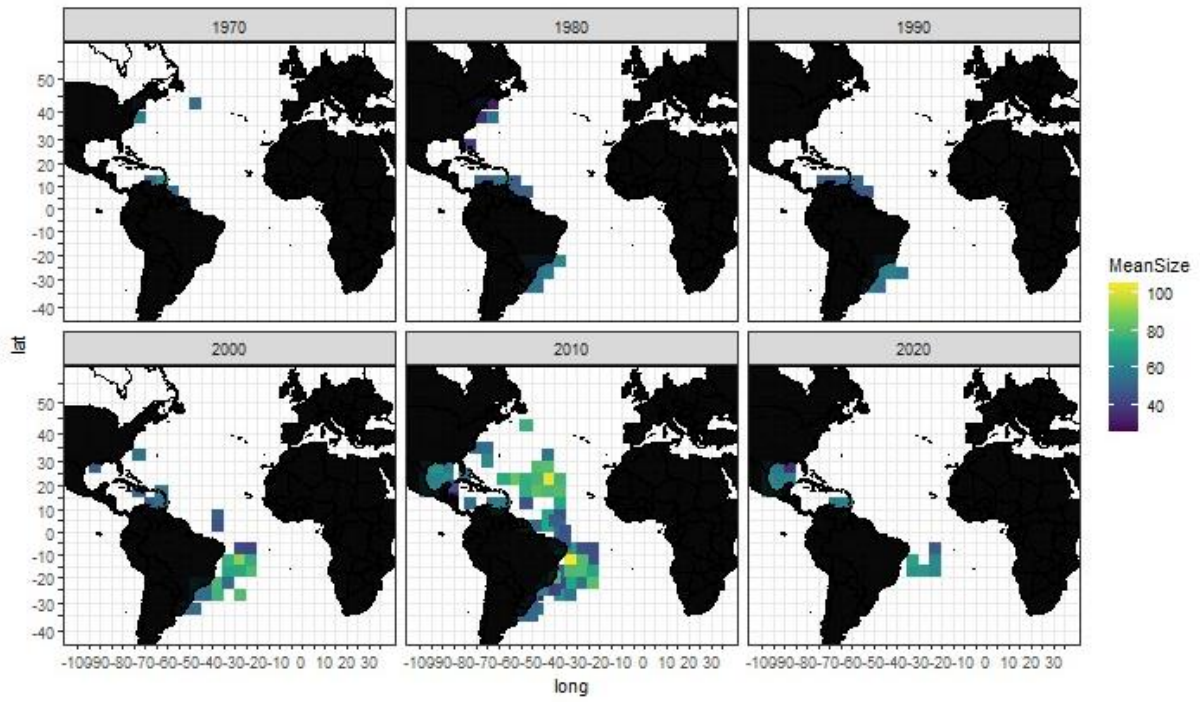

Figure 5. Mean size of Skipjack tuna from the Western Atlantic within 5°x5° quadrants sampled in different decades from 1970 to 2020.

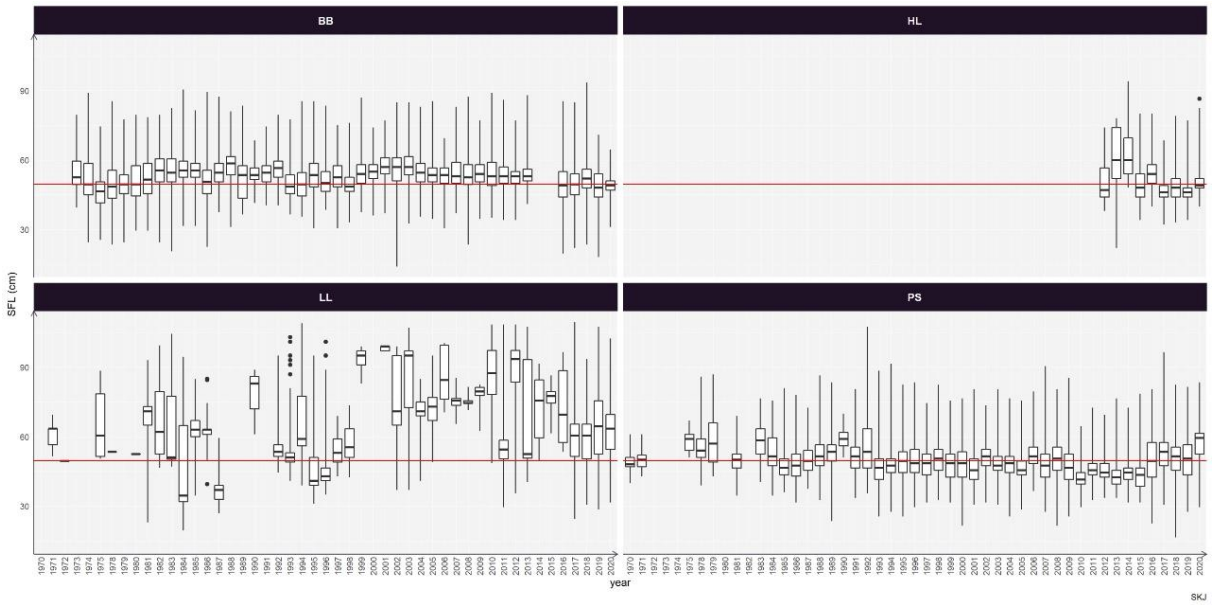

Figure 6. Boxplot of the yearly mean sizes of Skipjack tuna from the Western Atlantic for the main fishing fleets (BB: baitboat, HL: handline, LL: longline, and PS: purse seine). The red line indicates the overall mean among all sampled gears and years.