

REVIEW AND PRELIMINARY ANALYSES OF SIZE FREQUENCY SAMPLES OF YELLOWFIN TUNA (*THUNNUS ALBACARES*)

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SUMMARY

Size frequency data of Atlantic yellowfin was reviewed and preliminary analysis performed for its use within the stock evaluation models. Size data is normally submitted to the Secretariat by CPCs under the Task II requirements; optionally CPCs can submit Catch at Size, size samples or both for the major fisheries catching tropical tunas. The size samples data was revised, standardized and aggregated to size frequencies samples by fishery, calendar year and quarter. Preliminary analyses indicated a minimum number of 75 fish measured per size frequency sample. For the Atlantic stock, the size sampling proportion among the major fishing gears is consistent with the proportion of the catch; in general purse seine is well sampled compared to the longline or baitboat fisheries. The number of fish measured has increased substantially in the last decades for the tropical fisheries; however some potential duplicate reporting was uncovered and appropriate corrections were done.

RÉSUMÉ

Les données de fréquence de tailles de l'albacore de l'Atlantique ont été examinées et une analyse préliminaire a été réalisée afin d'être utilisée dans les modèles d'évaluation de stocks. Les CPC soumettent habituellement les données de taille au Secrétariat dans le cadre des exigences de la tâche II ; les CPC ont le choix de soumettre la prise par taille, les échantillons de taille ou les deux pour les principales pêcheries qui capturent des thonidés tropicaux. Les données d'échantillons de tailles ont été révisées, standardisées et agrégées aux échantillons de fréquences de taille par pêcherie, année calendaire et trimestre. Les analyses préliminaires indiquaient un nombre minimum de 75 poissons mesurés par échantillon de fréquences de tailles. Pour le stock de l'Atlantique, la proportion de l'échantillonnage de tailles entre les principaux engins de pêche ne coïncide pas avec la proportion de la capture ; en général, la pêcherie de senneurs est bien échantillonnée par rapport aux pêcheries de palangriers ou de canneurs. Le nombre de poissons mesurés a considérablement augmenté ces dernières décennies dans les pêcheries tropicales ; or, on a détecté d'éventuelles doubles déclarations et les corrections appropriées ont été apportées.

RESUMEN

Se revisaron los datos de frecuencia de tallas del rabil del Atlántico y se llevaron a cabo análisis preliminares para su uso en los modelos de evaluación de stock. Normalmente, las CPC envían los datos de talla a la Secretaría en el marco de los requisitos de Tarea II; opcionalmente, las CPC pueden enviar datos de captura por talla, muestras de talla o ambos para las principales pesquerías que capturan túnidos tropicales. Los datos de muestras de talla se revisaron, estandarizaron y agregaron a muestras de frecuencias de talla por pesquería trimestre y año civil. Los análisis preliminares indicaban un número mínimo de 75 ejemplares medidos por muestra de frecuencia de talla. Para el stock del Atlántico, la proporción de muestreo de tallas entre los principales artes pesqueros no es coherente con la proporción de la captura, en general, la pesquería de cerco está bien muestreada en comparación con las pesquerías de cebo vivo y palangre. El número de ejemplares medidos se ha incrementado notablemente en las últimas décadas para las pesquerías tropicales, sin embargo, algunas duplicaciones potenciales de la comunicación no han quedado cubiertas y se han realizado las correcciones apropiadas.

KEYWORDS

Mean size, yellowfin tuna, size frequency, size samples

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1. Introduction

Size samples for Atlantic yellowfin tuna (YFT) have been regularly submitted by the main fishing fleets targeting tropical tunas. Size and Catch at Size (CAS) information has been used as input for length base models (Anon. 2012; Anon 2009), and for estimating Catch at Age matrices for age-structure models in priors assessments (Anon 2012).

Following the recommendations and directions in the work plan for the YFT assessment in 2016, the Secretariat is providing a review and preliminary analysis of the available size information. This report aims to identify size samples representative of the fisheries defined by the Tropical WG by year and quarter and to consolidate and standardized the available information as input for the various assessment models.

2. Data

The size data represents primarily the Task II SZ data provided by CPCs, including also data from specific observer programs, sampling initiatives and recovery data provided by CPCs. In particular to highlight the submission of the actual YFT size measures data from the major EU tropical fisheries that it is included here, rather than the estimated CAS submitted annually. A systematic review with the collaboration of EU scientist clear out some potential duplicated in the size sample data for yellowfin tuna from the main EU AVDTH reports. The size data included the latest updates and modifications recommended by the WG during the Data preparatory meeting (Anon. 2016). Briefly, the reported size data included over 770 thousand records representing over 4.47 million measured fish. The size samples extend from 1956 until 2015 with an average between 50 and 150 thousand samples per year since 1980 (**Figure 1**). The majority of samples come from purse-seine gear (51%), follows by longline (29%) and bait-boat (15.7%). Since 1991 most size samples from PS identified if were caught from sets on free schools (FSC) or associated floating objects (FADs). Samples included those reported as fish size measures of FL (94%) or CFL/LD1 converted to FL (4.3%) and few weight measures converted to FL (0.6%).

Samples from Mediterranean Sea were excluded, as well samples where FL size was < 10 cm or > 250 cm, as considered outliers. The size samples were then aggregated by Fishery as defined by the WG in 2016 data preparatory meeting (Anon 2016) and following further intersessional discussions. A total of 26 fisheries were categorized and size frequency samples between 12 and 250 FL cm in 2 cm size-bin were combined by fishery, year, quarter (Jan-Mar, Apr-Jun, Jul-Sep, and Oct-Dec) and spatial geographic areas.

3. Methods

The main purpose of size frequency input data is to provide information to the assessment models of the size and or age distribution of the catch. This requires that the size frequency data be representative of the fleet catch. Within Catch-statistical models, size frequency samples are normally input as such and associated with a particular fishery fleet type and an index of abundance (see **Table 1** for details). Size samples were aggregated by year and quarter (Jan-Mar, Apr-Jun, Jul-Sep and Oct-Dec), and by spatial geographic areas where area 1 correspond to samples from north of the 25° north latitude, area 2n from 10° north latitude to 25° north latitude, area 2s to 15° south latitude to 10° north latitude, and area 3 south of 15° south latitude.

4. Results and Discussion

Size sampling of yellowfin is by comparison with other tunas relative sufficient, size sampling has increased in recent years (**Figure 3**). **Table 2** summarizes the distributions of size samples by year and fishery ID, overall most fisheries have several years of sampling, with exception of fishery 14, a longline fleet in the south-west Atlantic. However, the ratio of size sampling by fishery ID in reference to total catch is not consistent, and on average prior to 1980 almost all fisheries are substantially under sampled with exception of the Baitboat fishery 1 (**Table 3**). After 1980 fisheries 15 through 19, mostly longline fleets from the western Atlantic are not or under-sampled. By contrast fishery 21, a China-Taipei longline has substantially increased the size sampling in recent years (2004 forward) compared to the early part of this fishery. Otherwise most of the fishery ID's have good size sampling coverage.

Spatially, most of the sampling is from the area 2s (70%) that correspond to the Gulf of Guinea fishing grounds area where the main purse seine fleets operate (**Figure 2**). Although sampling has increased since the 1990's, spatially most wider coverage sampling were in the 1980's and 1970's where size samples from the western Atlantic and both north and south eastern Atlantic were collected (**Figure 2**). Instead in the 1990's and 2000's the majority of sampling is restricted to the Gulf of Guinea area and some from the Gulf of Mexico.

Grouped by main gear types; Baitboat, purse seine, longline, rod and reel and others, yellowfin show a rather bimodal size distribution of the catches sampled (**Figure 3**). Baitboat catches primarily fish within 30 to 70 cm FL, however there are larger fish also caught in this fishery. **Figure 4** summarized the mean size trends of the size sampling by fishery ID, indicating the large variance of size by fishery. In the 1970 the mean size from baitboat catches was close to 80 cm FL, followed by a decline trend to fish below 60 cm FL, then since the 1990 there is clearly size difference in the catches of Baitboat fleets, with some targeting smaller fish just over 40 cm FL, while other fleets catch larger fish. By comparison the longline fleets have catch mostly fish within 110 to 130 cm FL, annual trends indicated a slight decrease in mean size from the early 1960, 140 cm FL to 120 cm with some oscillation in recent decades but overall with a unimodal size distribution consistent throughout. Instead the purse seine fleet size catches shows a clear bimodal size distributions particularly since the 1980's (**Figure 3**). Where fleets targeting free schools (Fishery 3) catch large yellowfin (80 -140 cm FL), while fleets operating on FAD's have predominantly catches of smaller yellowfin (40 – 60 cm FL). The rod & reel gear which includes several types of hand line and recreational or sport fisheries in general catch fish within 70 to 110 cm FL (**Figure 4**). **Figure 5** shows the mean weight annual trends by main gear type, the weight was directly calculated from the FL size using the Caverivière conversion size-weight factor (1976).

The overall size distribution of sampled yellowfin tuna shows a bimodal distribution since the 1960's, with a peak around 40-60 cm FL, which has increased relative proportion in the latest years, and a mode wider peak within the 90 – 140 cm FL (**Figure 6**).

Therefore, of the available size data for YFT, once size samples were aggregated by fishery-year-quarter, size frequency observations were excluded for those where < than 75 fish were measured, effectively establishing a minimum size sample of 75. There are also indications of a spatial main gear type size interaction pattern, particularly for the baitboat fisheries, where smaller fish are caught in the area 2s, intermediate size in areas 2n and 3, and larger fish in area 1 (**Figures 7 and 8**). There is also some indication of spatial-gear interaction for the purse seine fleets, with larger size predominant in area 2s since 1985 while smaller fish is being caught in area 3. In contrast for the longline and rod and reel gear types there is not clear distinction in the mean size of yellowfin caught by area.

Literature Cited

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Table 1. Yellowfin fisheries ID definitions for the stock synthesis model as agreed by the Tropicals WG.

FisheryID	FisheryCode	Gear	AreaID	School	YearFrom	YearTo	FisheryCode2
1	PS-EU_early	PS	...	...	1963	1985	1_PS_ESFR2_6585 (early)
2	PS-EU_trans	PS	...	...	1986	2014	2_PS_ESFR2_8690 (transition)
3	PS-EU_fsc	PS	...	FSC	1991	2014	3_PS_ESFR2_9114 (Free school)
4	PS-EU_fad	PS	...	FAD	1991	2014	4_ESFR_FADS2_PS_9114
5	BBPS-GHA	BB+PS	...	...	1965	2014	5_BB+PS_Ghana_6514
6	BB_A2_SouthDakar	BB	2s,3	...	1962	2014	6_BB area 2, south of Dakar
7	BB-Dakar_early	BB	2n	...	1962	1980	7_BB_DAKAR_62_80
8	BB-Dakar_late	BB	2n	...	1981	2014	8_BB_DAKAR_81_14
9	BB-CaAzMd	BB	...	1 ...	1962	2014	9_BB_area1_can_AZ
10	LL_JPN_a1	LL	...	1 ...	1975	2014	Japan_LL_75_14_area1
11	LL_JPN_a2	LL	...	2 ...	1975	2014	Japan_LL_75_14_area2
12	LL_JPN_a3	LL	...	3 ...	1975	2014	Japan_LL_75_14_area3
13	LL_URY_early	LL	...	...	1982	1991	URU_LL_1
14	LL_URY_late	LL	...	...	1992	2010	URU_LL_2
15	LL_BR	LL	...	...	1978	2011	BR_LL
16	LL_VEN	LL	...	...	1970	2001	VEN_LL
17	LL_US	LL	...	...	1987	2014	US_LL
18	LL_TAI_a1_early	LL	...	1 ...	1970	1992	CH_TAI_LL_1_70_92_area1
19	LL_TAI_a1_late	LL	...	1 ...	1993	2014	CH_TAI_LL_2_93_14_area1
20	LL_TAI_a2_early	LL	...	2 ...	1970	1992	CH_TAI_LL_1_70_92_area2
21	LL_TAI_a2_late	LL	...	2 ...	1993	2014	CH_TAI_LL_2_93_14_area2
22	LL_TAI_a3_early	LL	...	3 ...	1970	1992	CH_TAI_LL_1_70_92_area3
23	LL_TAI_a3_late	LL	...	3 ...	1993	2014	CH_TAI_LL_2_93_14_area3
24	LL_others	LL	...	...	1950	2014	OTHER_LL
25	RR_USA	RR (95% of oth)	...	...	1970	2014	US_RR
26	Others	oth	...	...	1950	2014	OTH_OTH

Table 2. Summary of yellowfin size samples by fishery ID and year. The values represent the distribution in percent by total by fishery ID. Color shades are proportional to the percentage with blue representing low and red high percentages, respectively.

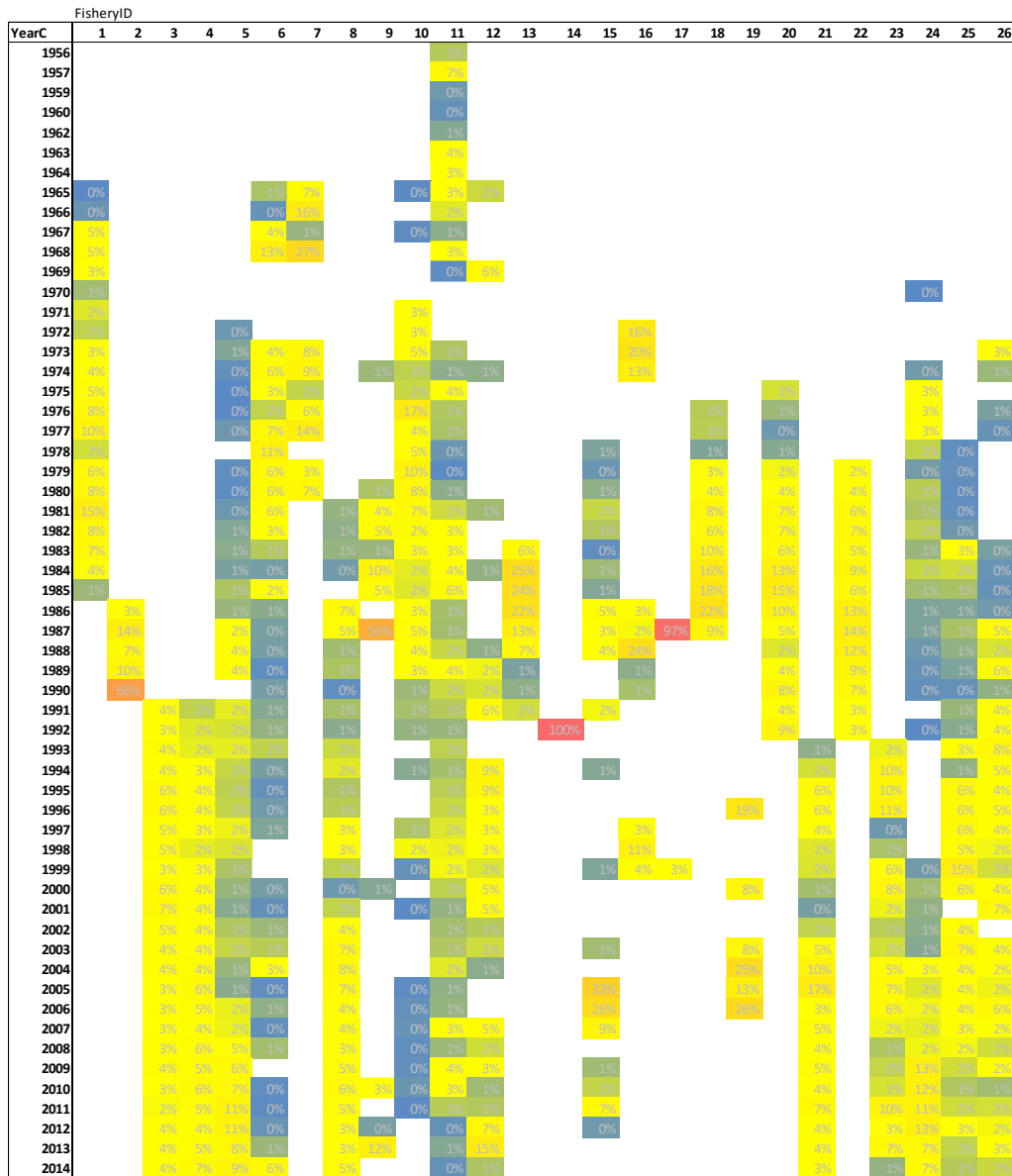


Table 3. Ratio of the percent size samples to percent catch YFT by fishery ID and year. The red shades represent very low or none size sampling with respect to the catch, while the green shades indicates very high size samples in relation to the proportion of the catch; yellow shades will indicate ratios around 1, where the size sampling is proportional to the catch in that year-fishery ID strata.

Year	FisheryID																											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26		
1950																												
1951																												
1952																												
1953																												
1954																												
1955																												
1956					0.00	0.00					11.89														0.00	0.00		
1957					0.00	0.00					2.89														0.00	0.00		
1958					0.00	0.00					0.00				0.00	0.00									0.00	0.00		
1959					0.00	0.00					0.04	0.00			0.00	0.00									0.00	0.00		
1960					0.00	0.00					0.02	0.00			0.00	0.00									0.00	0.00		
1961					0.00	0.00					0.00	0.00			0.00	0.00									0.00	0.00		
1962					0.00	0.00			0.00	0.00	0.09	0.00			0.00	0.00	0.00			0.00		0.00			0.00	0.00		
1963	0.00				0.00	0.00			0.00	0.00	0.63	0.00			0.00	0.00	0.00			0.00		0.00			0.00	0.00		
1964	0.00				0.00	0.00			0.00	0.00	0.46	0.00			0.00	0.00	0.00			0.00		0.00			0.00	0.00		
1965	0.08				0.33	1.33			0.00	0.04	0.44	1.11			0.00	0.00				0.00		0.00			0.00	0.00		
1966	0.23				0.07	3.03			0.00	0.00	0.49	0.00			0.00	0.00				0.00		0.00			0.00	0.00		
1967	3.88				0.99	0.16			0.00	0.07	0.35	0.00			0.00	0.00				0.00		0.00			0.00	0.00		
1968	2.34				2.65	3.50			0.00	0.00	1.07	0.00			0.00	0.00				0.00		0.00			0.00	0.00		
1969	0.91				0.00	0.00			0.00	0.00	0.06	1.73			0.00	0.00				0.00		0.00			0.00	0.00		
1970	0.47				0.00	0.00			0.00	0.00	0.00	0.00			0.00	0.00				0.00		0.00			0.01	0.00		
1971	0.88				0.00	0.00			0.00	0.27	0.00	0.00			0.00	0.00				0.00		0.00			0.00	0.00		
1972	0.44				612.82	0.00	0.00		0.00	0.48	0.00	0.00			0.00	4.23				0.00		0.00			0.00	0.00		
1973	1.04				22.39	1.04	2.24			1.04	3.97	0.00			0.00	6.40				0.00		0.00			0.00	30.53		
1974	1.13				2.48	1.42	1.52			0.28	0.37	2.33	4.31		0.00	6.93				0.00		0.00		0.08	0.00	9.06		
1975	0.89				0.18	1.76	0.45			0.00	0.62	6.73	0.00		0.00	0.00				0.58		0.00		0.63	0.00	0.00		
1976	1.30				0.19	0.57	1.44			0.00	2.61	9.54	0.00		0.00	0.00				1.42		0.00		1.00	0.00	1.62		
1977	1.54				2.08	3.31	3.86			0.00	1.60	15.07	0.00		0.00	0.00				2.13		0.00		0.62	0.00	0.32		
1978	0.26				0.00	6.38	0.00			0.00	1.50	3.24	0.00		0.59	0.00				2.99		0.00		0.53	12.20	0.00		
1979	0.92				0.49	1.89	0.98			0.00	2.71	0.77	0.00		0.23	0.20				3.24		0.78		0.21	10.91	0.00		
1980	1.10				0.21	5.17	2.38			7.69	4.55	1.97	0.00		1.33	0.00	0.00			8.42		1.20		0.56	4.21	0.00		
1981	1.84				0.22	3.72		0.37	20.81	1.39	4.44	1.85	0.00		1.18	0.00				10.70		2.69		0.58	0.10	0.00		
1982	0.99				0.27	2.07		0.26	7.14	3.11	2.73	0.00	0.00		1.20	0.00	0.00			11.82		7.94		0.69	0.35	0.00		
1983	0.91				0.40	0.96		0.33	0.73	3.80	9.15	0.00	0.35		0.12	0.00	0.00			17.57		1.72		0.58	1.28	0.13		
1984	0.85				0.23	0.48		0.11	1.58	4.67	5.75	0.79	1.41		1.85	0.00	0.00			36.83		11.58		0.88	3.48	0.13		
1985	0.14				0.40	2.39		0.00	0.95	3.24	6.77	0.00	1.39		1.06	0.00	0.00			23.24		3.61		0.57	0.26	0.21		
1986					0.33	2.41		1.94	0.00	1.96	3.32	0.00	1.71		3.58	2.19	0.00			15.46		4.03		0.23	0.11	0.30		
1987		0.19			0.99	0.86		1.02	10.43	2.52	3.13	0.00	2.41		3.87	2.31	18.34			17.24		2.29		0.29	0.26	6.07		
1988		0.45			2.05	0.65		0.22	0.00	1.66	2.33	0.16	0.78		3.49	20.63	0.00			2.28		0.83		0.19	0.36	2.26		
1989		0.43			2.47	0.15		0.34	0.00	1.59	3.40	2.98	0.17		0.00	1.00	0.00			4.43		2.42		0.13	0.26	7.09		
1990		2.49			0.00	0.50		0.09	0.00	0.46	1.92	1.28	0.95		0.00	2.83	0.00			0.85		0.98		0.09	0.19	1.07		
1991					0.57	0.35	0.93	1.06		0.23	0.00	0.51	2.51	1.60	0.60	3.35	0.00	0.00	0.00	0.82		0.25		0.00	0.54	0.74		
1992					0.53	0.40	0.82	0.75		0.20	0.00	3.20	2.00		30.80	0.00	0.00	0.00		1.73		0.24		0.03	0.59	1.06		
1993					0.78	0.39	0.64	1.18		0.48	0.00	0.00	2.98	0.00		0.00	0.00	0.00		0.00		0.17		0.24	0.00	1.45	1.57	
1994					0.79	0.49	0.65	0.37		0.50	0.00	0.72	1.87	1.88		0.00	0.51	0.00	0.00		0.00		0.28		0.53	0.00	0.17	0.78
1995					1.17	0.72	0.65	0.14		0.50	0.00	0.00	2.08	1.67		0.00	0.00	0.00	0.00		0.00		0.87		2.75	0.00	1.28	0.85
1996					1.23	0.80	0.78	0.41		0.56	0.00	0.00	1.95	1.28		0.00	0.00	0.00	0.00		3.65		0.64		1.46	0.00	1.38	1.22
1997					1.08	0.80	0.59	0.69		1.22	0.00	2.67	3.85	1.11		0.00	0.00	5.41	0.00		0.00		0.56		0.14	0.00	1.58	0.93
1998					0.91	0.73	0.59	0.00		1.21	0.00	2.22	3.14	0.69		0.00	0.00	12.72	0.00		0.00		0.28		0.44	0.00	1.57	0.58
1999					0.81	0.99	0.34	0.00		0.36	0.00	0.27	4.56	1.21		0.00	0.17	5.49	0.91		0.00		0.37		1.24	0.18	3.43	0.58
2000					1.53	1.17	0.31	0.34		0.12	1.33	0.00	2.88	1.18		0.00	0.00	0.00	0.00		0.89		0.16		1.07	0.55	1.48	1.55
2001					1.36	1.30	0.12	0.26		0.49	0.00	0.05	2.37	4.92		0.00	0.00	0.00	0.00		0.00		0.10		0.27	0.66	0.00	1.73
2002					0.95	1.50	0.29	0.90		1.24	0.00	0.00	3.71	1.35		0.00	0.00	0.00	0.00		0.00		0.31		0.14	0.90	1.37	2.00
2003					0.99	1.28	0.43	2.01		2.79	0.00	0.00	3.64	0.94		0.00	0.48	0.00	0.00		3.14		0.59		0.30	0.67	1.27	2.25
2004					1.25	1.32	0.28	2.26		2.36	0.00	0.00	2.22	0.24		0.00	0.00	0.00	0.00		11.19		1.28		1.05	1.36	1.06	1.14
2005					0.97	2.13	0.23	0.13		3.04	0.00	0.06	1.27	0.00		0.00	5.88	0.00	0.00		4.48		3.32		2.61	1.84	1.15	1.55
2006					0.99	1.75	0.67	1.33		1.94	0.00	0.24	1.30	0.00		0.00	16.17	0.00	0.00		6.29		2.19		3.36	1.10	0.74	2.65
2007					1.18	1.70	0.80	0.24		2.79	0.00	1.07	2.10	4.80		0.00	4.59	0.00	0.00		0.00		1.93		1.97	1.01	1.01	0.93
2008					0.92	1.57	1.57	5.06		3.49	0.00	1.16	0.91	1.75		0.00	0.00	0.00	0.00		0.00		2.39		1.83	1.19	2.18	0.64
2009					1.03	1.69	2.11	0.00		3.32	0.00	2.19	4.77	1.74		0.00	0.87	0.00	0.00		0.00		2.54		2.35	7.20	1.61	1.04
2010					0.75	1.48	2.82	0.37		4.05	1.87	1.88	4.29	0.44		0.00	1.17	0.00	0.00		0.00		3.20		2.80	7.19	1.01	0.33
2011					0.74	1.10	4.87	0.12		2.24	0.00	0.62	2.13	0.37		0.00	3.23	0.00	0.00		0.00		2.80		5.01	9.22	1.13	0.93
2012					1.13	0.72	4.49	1.44		1.40	2.54	0.00	0.24	2.31		0.00	0.17	0.00</										

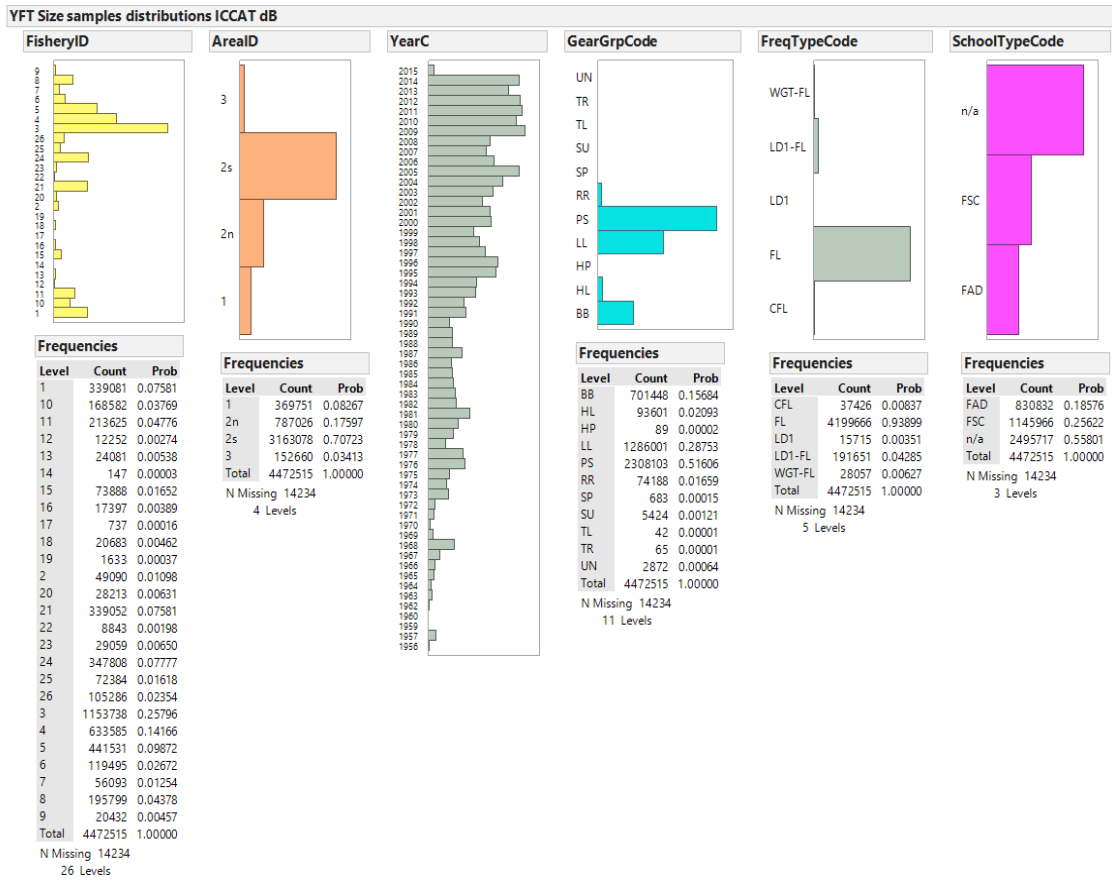


Figure 1. Yellowfin tuna size samples (Task II SZ) summary distributions by Fishery ID, Area, year, gear type, measure type and fishing associated type (Free schools FSC, FADs, and unclassified).

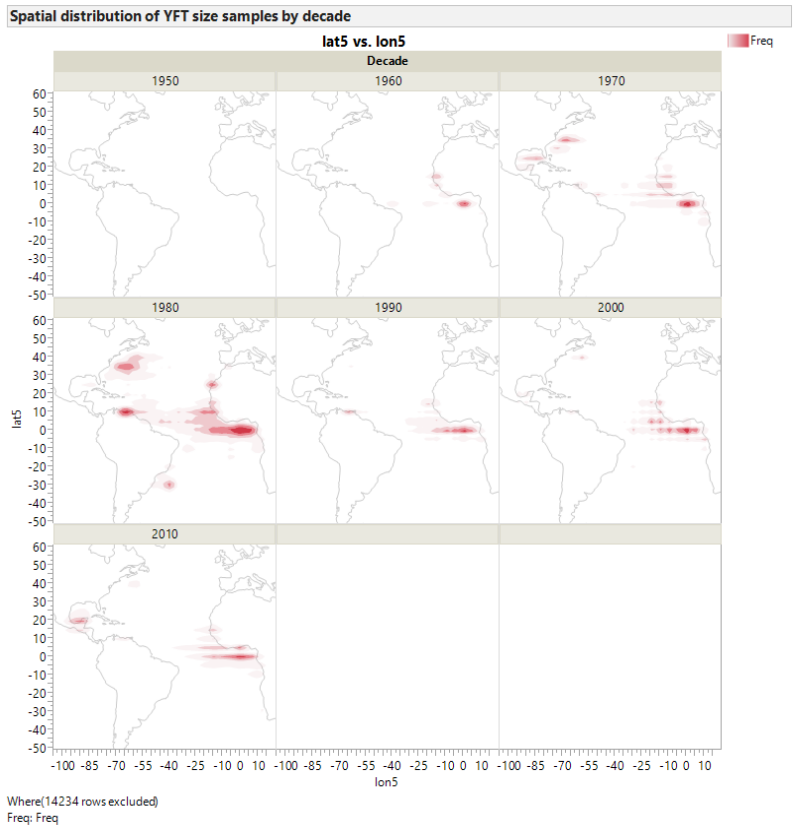


Figure 2. Spatial distribution of yellowfin size samples by decade and 5x5 square degrees. Color intensity is proportional to number of fish measured.

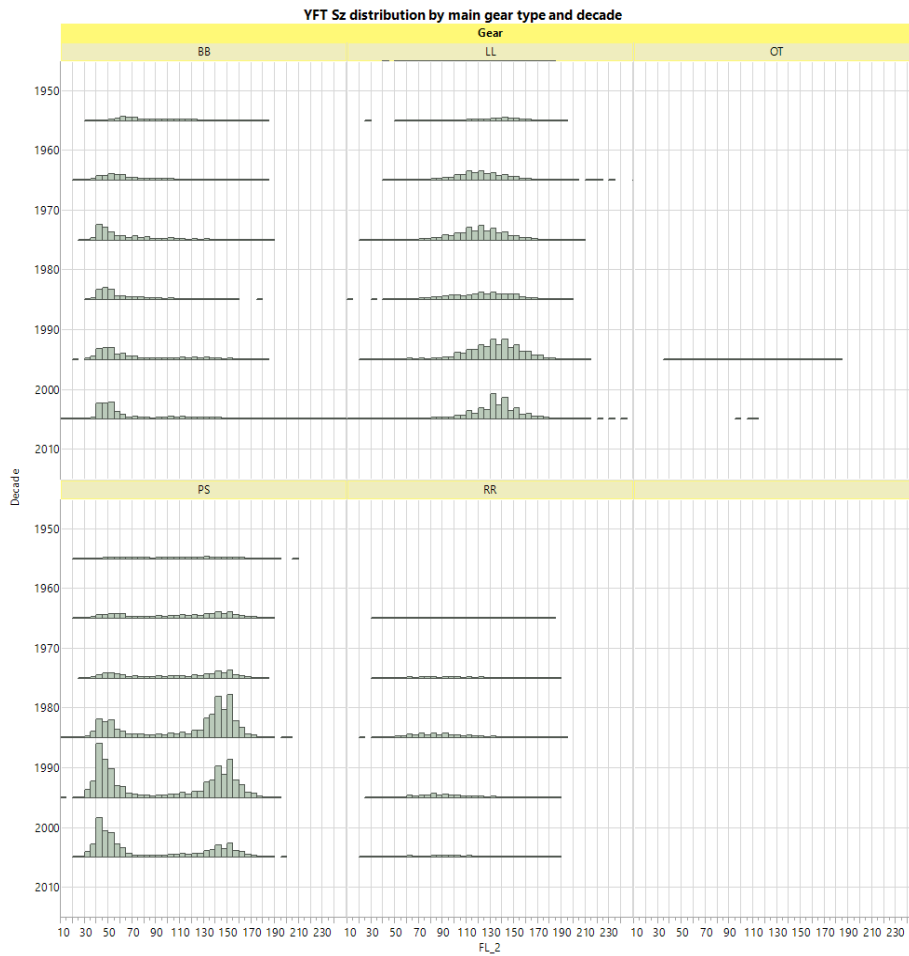


Figure 3. Size distributions by decade and main gear type (baitboat BB, longline LL, purse seine PS, rod & reel RR and others OT) for yellowfin tuna.

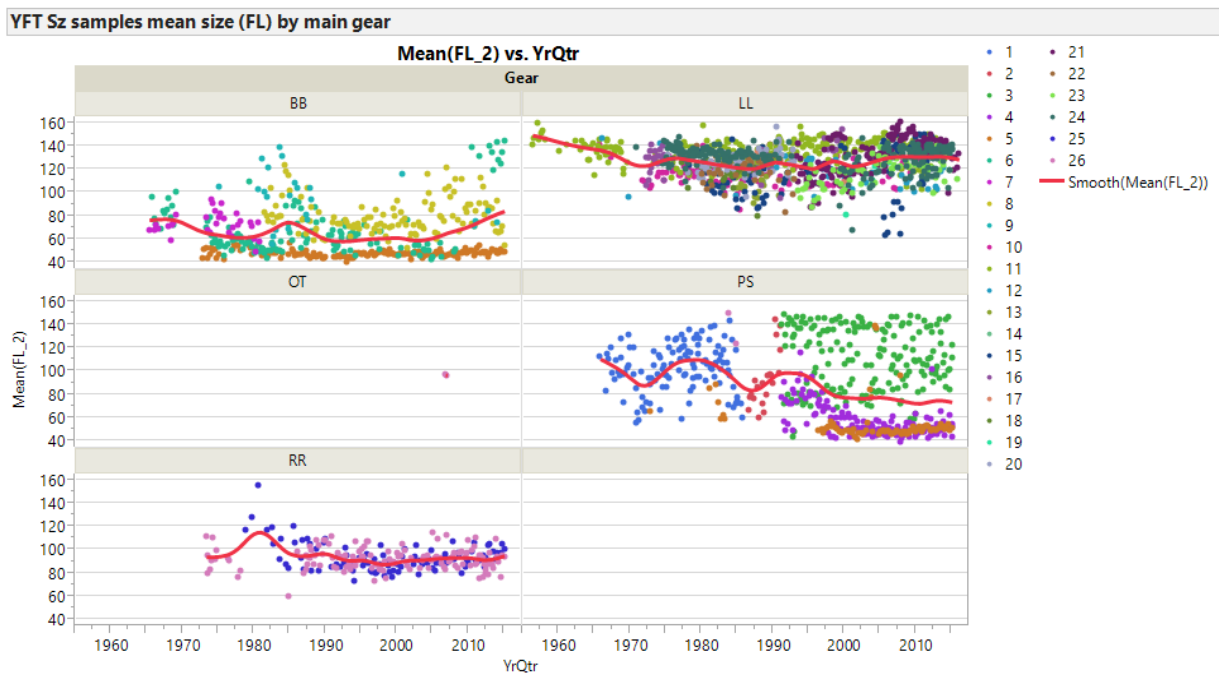


Figure 4. Annual trends of mean size (FL cm) of size sampled yellowfin tuna by main gear type and fishery ID (marker color) by year. Solid lines represent a smoother trend of the data.

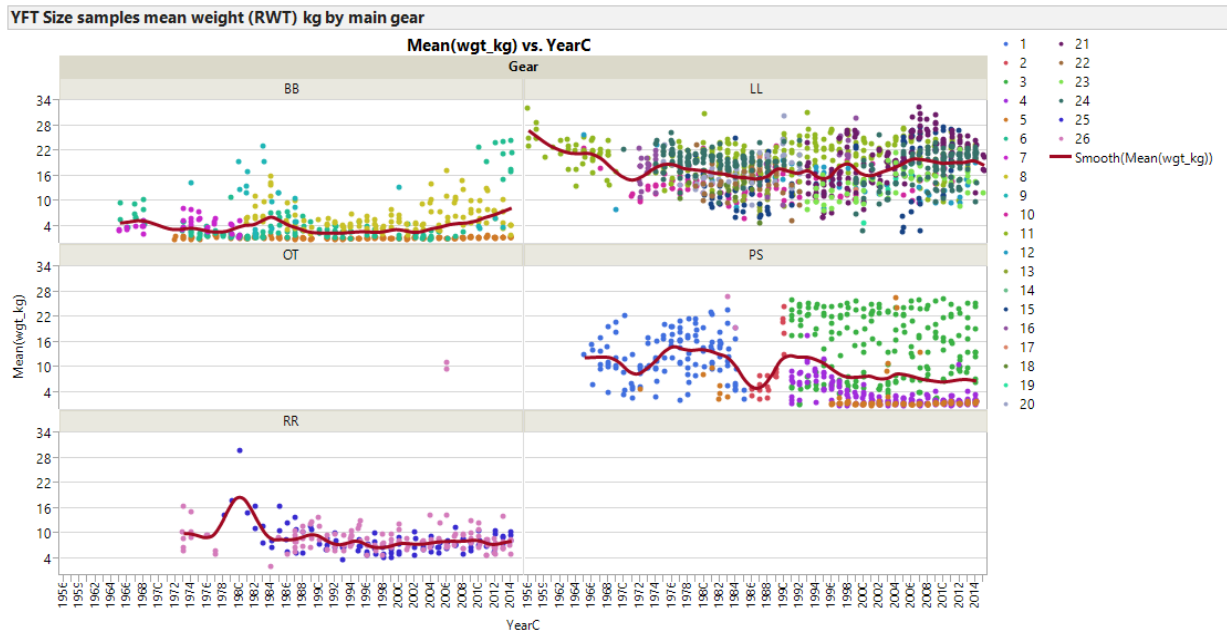


Figure 5. Annual trends of mean weight (RWT kg) of size sampled yellowfin tuna by main gear type and fishery ID (marker color) by year. Solid lines represent a smoother trend of the data.

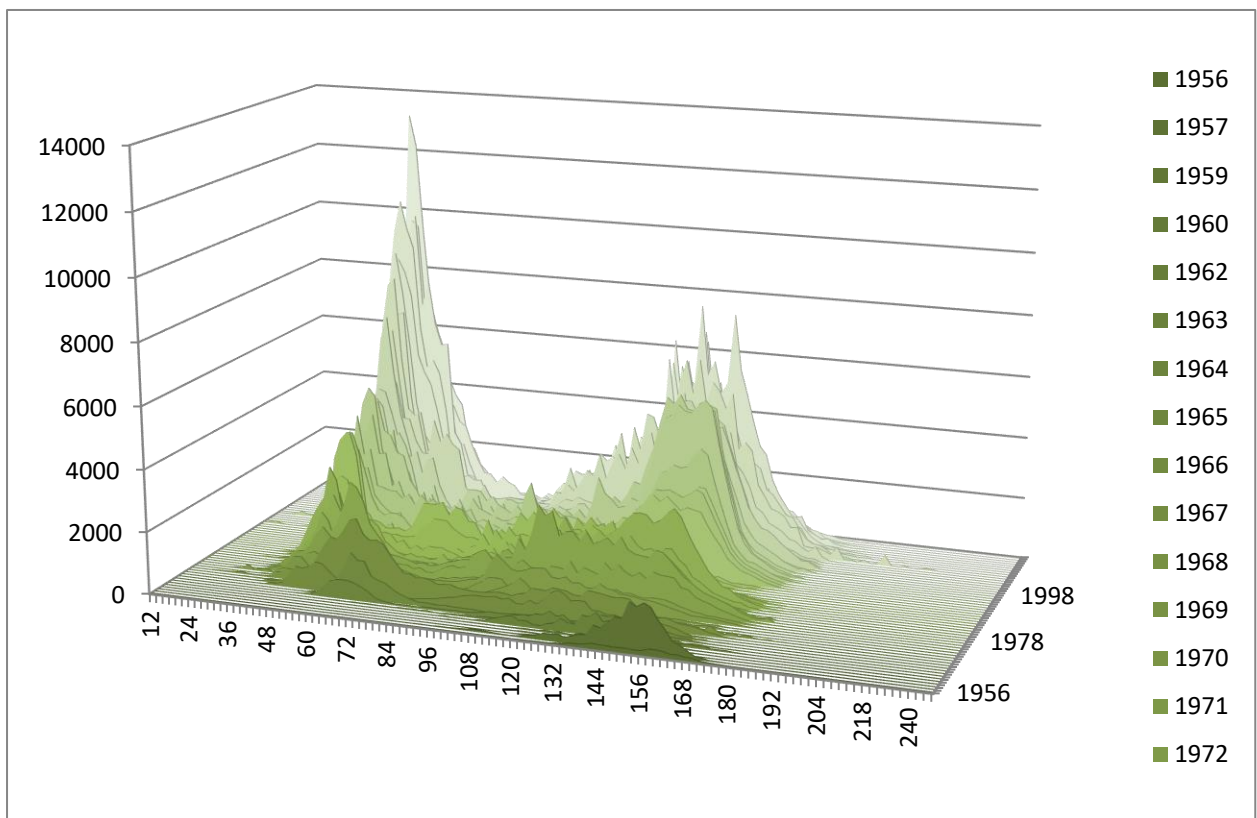


Figure 6. Overall summary of the sampled yellowfin tuna size (FL cm) data distributions by year.

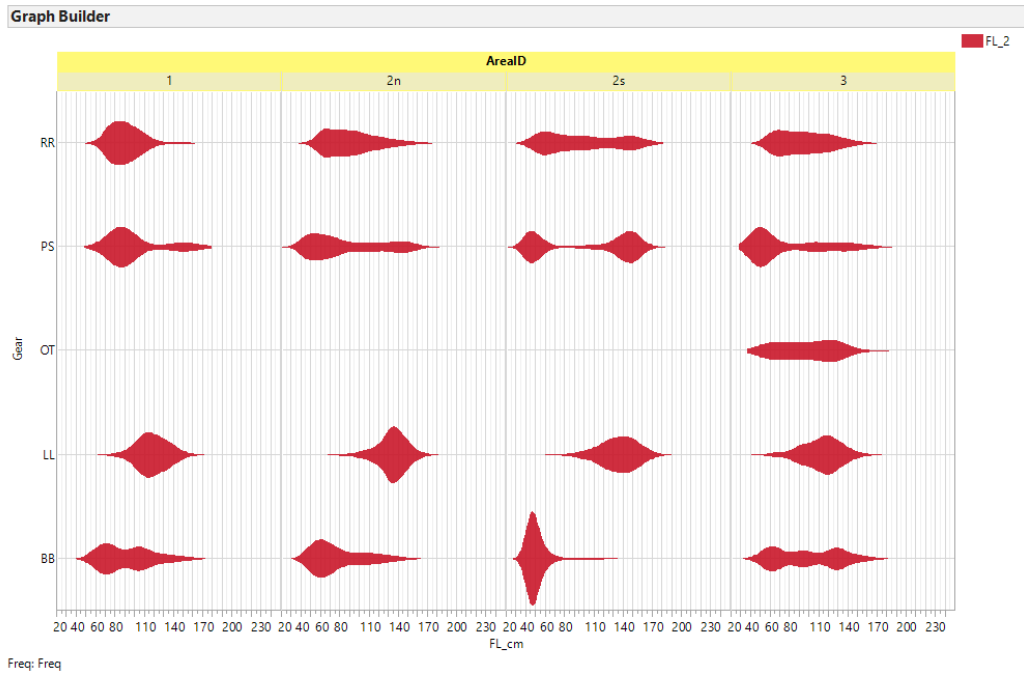


Figure 7. Size frequency distribution of yellowfin tuna by main gear type and geographic areas.

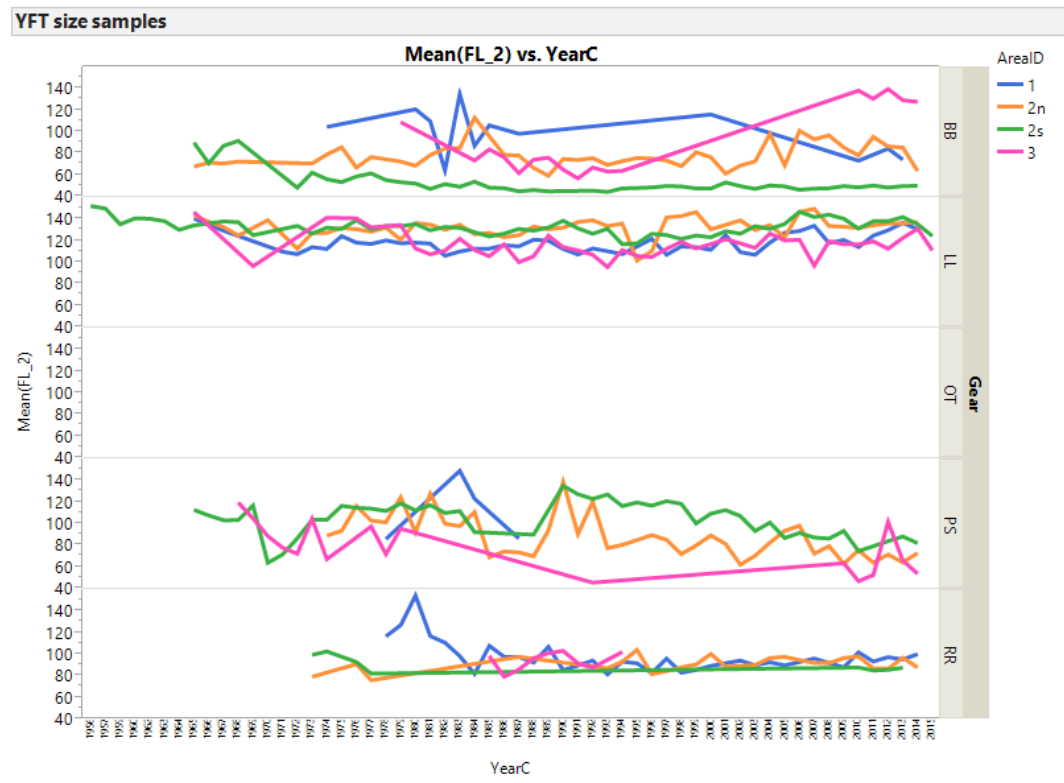


Figure 8. Yellowfin mean size (FL cm) by main gear type and geographical area.