REVIEW AND PRELIMINARY ANALYSES OF SIZE-FREQUENCY SAMPLES OF MEDITERRANEAN ALBACORE TUNA (*THUNNUS ALALUNGA*)

M. Ortiz[1], C. Mayor, and C. Palma

SUMMARY

Size frequency data of the Mediterranean albacore was reviewed, and preliminary analysis was performed for its potential use within the stock evaluation models. The size samples were revised, standardized, and aggregated to size frequencies samples by, main gear type, calendar year, and quarter. Preliminary analyses use the number of size samples and indicators of distribution shape (skewness and kurtosis) to evaluate the suitability of a size-frequency sample. Limited size samples are available before the 1990s, and the number of samples has reduced significantly in recent years. Overall, most of the fish caught is between 58 and 90 cm SFL, with a median of 73 cm SFL. For the Mediterranean albacore stock, currently, the size-frequency samples from the major target fishing gear suggest a passing of annual cohorts in the fishery.

RÉSUMÉ

Les données de fréquence des tailles du germon de la Méditerranée ont été examinées et une analyse préliminaire a été réalisée afin d'être potentiellement utilisée dans les modèles d'évaluation de stocks. Les échantillons de tailles ont été révisés, standardisés et agrégés en échantillons de fréquences de tailles par type d'engins principaux, années civiles et trimestres. Les analyses préliminaires utilisent le nombre d'échantillons de tailles et les indicateurs de la forme de distribution (asymétrie et aplatissement) pour évaluer la pertinence d'un échantillon de fréquence de tailles. Des échantillons de tailles limités sont disponibles avant les années 1990 et le nombre d'échantillons s'est considérablement réduit ces dernières années. Dans l'ensemble, la plupart des poissons capturés mesurent entre 58 et 90 cm SFL, avec une médiane de 73 cm SFL. Pour le stock de germon de la Méditerranée, actuellement, les échantillons de fréquences de tailles du principal engin de pêche cible suggère un passage des cohortes annuelles dans la pêcherie.

RESUMEN

Se revisaron los datos de frecuencia de tallas del atún blanco del Mediterráneo, y se llevaron a cabo análisis preliminares para su posible uso en los modelos de evaluación de stock. Las muestras de tallas fueron revisadas, estandarizadas y agregadas a muestras de frecuencias de tallas por tipo de arte principal, año natural y trimestre. Los análisis preliminares utilizan el número de muestras de talla y los indicadores de la forma de la distribución (asimetría y curtosis) para evaluar la idoneidad de una muestra de frecuencia de talla. Se dispone de muestras de talla limitadas antes de la década de 1990, y el número de muestras se ha reducido considerablemente en los últimos años. En general, la mayoría de los peces capturados se encuentran entre 58 y 90 cm de SFL, con una mediana de 73 cm de SFL. En el caso del stock de atún blanco del Mediterráneo, actualmente, las muestras de frecuencias de tallas del principal arte de pesca objetivo sugieren el paso de cohortes anuales en la pesquería.

---

[1] ICCAT Secretariat. Corazón de Maria 8, Madrid, Spain 28002. Mauricio.ortiz@iccat.int

1. Introduction

Size samples for Mediterranean albacore have been regularly submitted by the main fishing fleets targeting and from bycatch fisheries. Size information has been reviewed as input for assessment models (Anon, 2017).

Following the recommendations and directions in the work plan for the Mediterranean Albacore assessment in 2020, the Secretariat is providing a review and preliminary analysis of the available size information. This report aims to identify size-frequency samples representative of the main fleets by year and quarter and to consolidate and standardize the available information as input for the different assessment models.

2. Data

The ICCAT albacore task 2SZ data comprises size information from 1975 to 2019. For the Mediterranean stock size samples from main fleets are mostly available since 1991, the number of size samples increased only after 1990, with the highest peak in 1996. Since then the size sampling has declined to about 3 thousand in recent years (**Figure 1**).

Size data has been submitted by 7 Flags and at least 20 different types of fishing gears (**Figure 2**). Fork length (FL) is the main size measurement reported (97%), with few as weight frequency samples (WGT, 3%). Overall a total of 115,429 fish size measurements were available. Size ranges from 7 to 302 SFL cm for the Mediterranean stock (**Figure 3**). A priori, it was excluded observations with SFL sizes below 20 cm and above 200 cm, as the maximum size from growth studies is about 100 SFL cm (Megalofonou, 2000; Quelle *et al.,* 2011). For standardization, all measures were converted to SFL and rounded to 1 cm bin size intervals. Five main fishing gears were defined; albacore longline target (LL TG), longline bycatch (LL BYC), Surface gears including, trolling (TR), gillnets (GN), bait boat (BB), and rod & reel (RR), and others gears category (OTH) which includes fewer size observations from purse-seines and unclassified gears. The quarter was calculated from the month or quarter information provided; samples with year information only (6%) were randomly assigned to quarters 2, 3, and 4 where most of the catch takes place.

All size-frequency samples were then aggregated by major gear type, year, and quarter. This generated 218 size-frequency samples for the Mediterranean stock. Over these samples, further analysis was performed to identify size frequencies that are likely representative of a particular fishery and exclude outliers.

3. Methods

The main objective 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 main fleet's catch. For Catch-statistical models, size-frequency samples are normally input as such and associated with a particular fleet type and/or index of abundance, therefore, it is important to evaluate if a given size-frequency sample is representative or not. As done in prior analyses, normally a combination of statistical indicators has been used to inform whether size-frequency data is suitable or not. Of these indicators, the sample size is the initial one to be evaluated. Then other indicators of the frequency distribution are evaluated often assuming that a "*representative size sample*" from a given gear-fleet and area-time strata should follow a more and less normal distribution.

Besides the evaluation of individual size-frequency samples, it was considered also the proportionality between size samples and the total catch by major gears. In an optimal sampling scheme, the percent of size samples by gear type should reflect the percent of catch by the different gears fleets within a given year. **Figure 4** shows the spatial distribution of size samples for Med ALB all years by the main type of gear (points represent the centroid of the area strata reported, in some cases, e.g. 5x5 lat lon, these centroids fall on land). The longline sampling covers most of the Mediterranean Sea, both from the LL target and bycatch fleets. However, for other gear there are limited samples by gear type and area, still, some size samples have not associated gear of catch.

4. Results and Discussion

In reference to the number of fish within a size-frequency sample, it is been suggested 20 fish as a minimum sample size. **Figure 5** shows the number of fish measured by year for each main flat and gear type, red cells indicate size samples with fewer fish, green cells indicate more than 500 fish, yellow shades the intermediate

values, and empty cells no size samples. For the Mediterranean stock longline target albacore and longline bycatch, gear is relatively good sampling since the 2000s. However, surface gears like troll and rod and reel, are poorly size sampled, and historic catches from gillnet fisheries are also poorly size sampled. It is noticeable also the large fluctuations in the number of size samples, likely due to "estimations" of size measurements from the CAS. This, however, can be only reviewed by national scientists.

Figure 6 shows the catch by main gear (Task I) for the Mediterranean albacore stock. Surface gears, gillnets, trolling or hand lines were the major fleet/gears catching albacore in the Mediterranean Sea before the 1980s, during the 1990's a transition of fleet/gears was observed, with the increased catch of bait boat, and longline gears, although gillnets still were predominant in this period. Then after 2000, longline both targeting albacore and as bycatch from other fisheries, mainly Mediterranean swordfish, became the main fishing gear, this coincided with the ban of the drifted gillnets during this period. Since 2010 over 90% of the Med Albacore catch is by the longline gear fleets.

The evaluation of the skewness and the kurtosis of each size-frequency sample was performed. As indicated a size-frequency sample is been defined as the aggregated size measures by stock, gear, year, and quarter. **Figure 7** shows the distributions of skewness and kurtosis of 218 size-frequency samples, outlier were considered those size-frequency samples which fall outside of their 95% quantile distributions (-1.711 < skewness < 2.84, -3.30 < kurtosis < 20.74), respectively.

After the evaluation of sample size, skewness, and kurtosis, of the 218 size-frequency samples, 161 (74%) were concluded as representative of the catch for Mediterranean albacore stock. **Figure 8** shows the annual trend of the medians for each size-frequency sample by major gear. Overall the mean size of Med-ALB has shown a relatively stable trend with a median size ranging from 70 to 80 cm SFL from 1984 to 2019. The size range covers from 40 to 110 cm in most years. By main gear, only the catches from longline bycatch particularly in the 1990's show a higher mean size of fish caught, or about 80-85 cm SFL, but in recent years this difference in mean size is no longer apparent. The longline target and surface gears, which in the 1990s are mainly troll operations, show similar size trends. The gear category others, that groups few samples from purse seine and unknown gears primarily in the 1980s show a wider size range and slightly lower mean size of about 70 cm SFL catches. Similar information is shown in **Figure 9** aggregated to all years. The cumulative density plots show that the longline target has on average the largest median size (73 cm SFL), while the longline bycatch median size is the smallest (64 cm SFL), surface and other gears median size is 68 and 70 cm SFL, respectively. To note the bimodal pattern of the size catch for the longline bycatch gear, associated with the large sizes of fish caught during the 1990s. 95% percentile of Med ALB caught is between 58 and 90 cm SFL.

Figure 10 shows the kernel density distributions by main gear/fleet for each year. The annual size distributions for the longline target gear, the gear/fleet with more information, show a series of size-progressions indicating the passing of cohorts, for example in 2000 to 2004, then another from 2007 to 2009/10, and recently from 2015 to 2017. In the longline bycatch gear/fleet the limited number of observations preclude any conclusions, for other gear/fleets that represent a mixture of different gears the size-distribution densities show no pattern.

In summary, the Mediterranean albacore size sampling can be improved, particularly is worrying the reduction on size samples in recent years. Historically, there is the need to recover the type of gear for sample in the 1980-1990s, and national scientists need to revise the original size measurements to confirm that actual size measurements have been provided and not adjusted CAS information. For the current longline target fleet, there is some evidence of cohorts moving through the fishery, it should be emphasized the need of suitable and representative sampling of these fleets to better inform assessment models.

Literature Cited

Anon. 2017. Report of the 2017 ICCAT Albacore species group intersessional meeting (including assessment of the Mediterranean Albacore (Madrid, Spain, June 5 to 9, 2017). Collect. Vol. Sci. Pap. ICCAT, 74(2): 508-583.

Megalofonou, P. 2000. Age and growth of Mediterranean albacore. J. Fish. Biol. 57(3): 700-715.

Quelle, P., V. Ortiz de Zarate, P.L. Luque, M. Ruiz, and X. Valeiras. 2011. A review of Mediterranean albacore (*Thunnus alalunga*) biology and growth studies. Collect. Vol. Sci. Pap. ICCAT, 66(5):1882-1896.
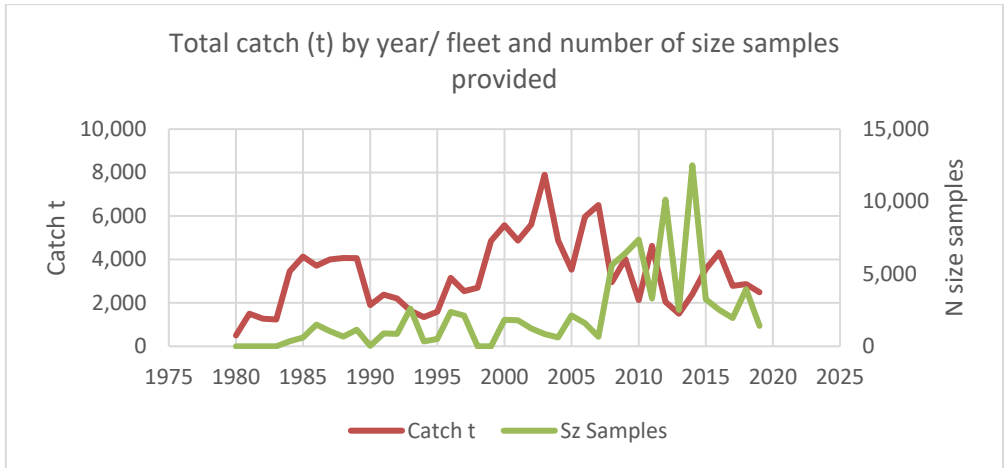
Figure 1. Mediterranean albacore total catch (t) and the corresponding number of size samples (right *y-axis*) available by year, 1980 - 2019.
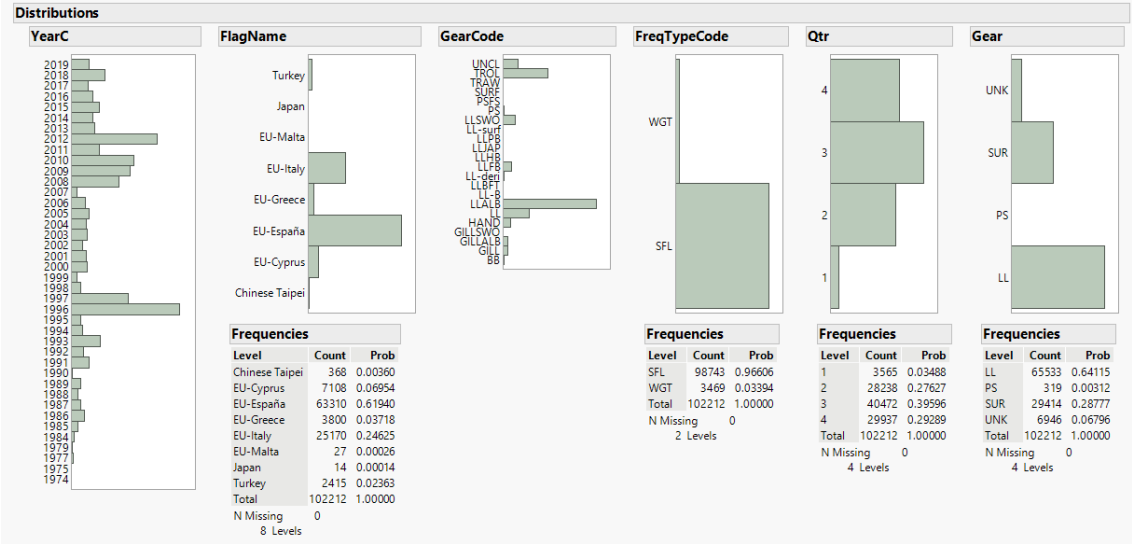
Figure 2. Distributions by year, flag, gear, type of measure (FreqTypeCode), quarter, and main gear type for the size data of Mediterranean albacore.

Figure 3. Med-ALB size distribution (SFL cm) for the available size data submitted by catching CPCs.
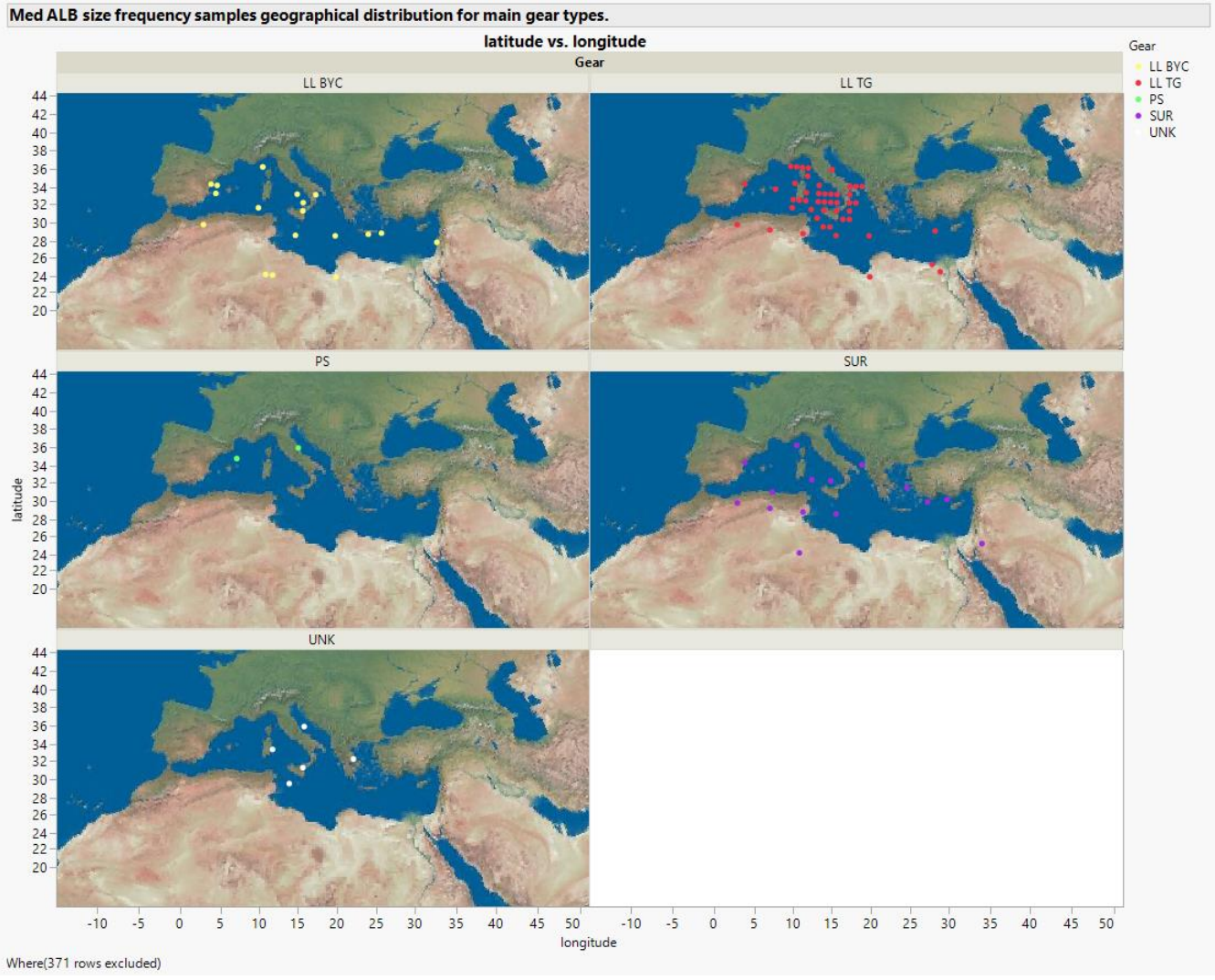
Figure 4. Spatial distribution of Mediterranean albacore size samples by main fishing gear type. Dots indicate the centroid of the strata area reported for the samples, in some cases e.g. 5x5 lat-lon the centroid points fall on land.

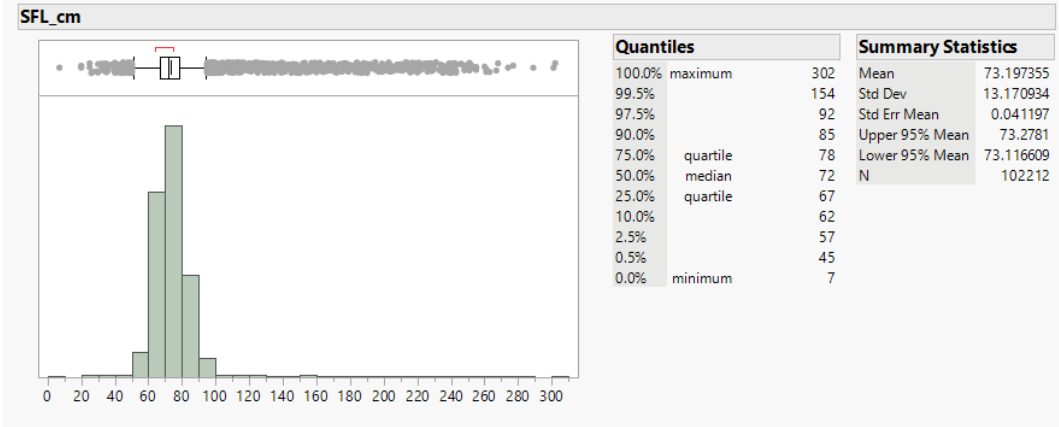| Flag	GearGrpCo	FleetName	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
EU.Cyprus	LL	Longline ALB																					53	376	286	425	810	793	1161		415	867	609	325	167	751
		Longline Byc																															2		9	
EU.España	BB	Surface gears	350																																	
	HL	Surface gears																							1107	560	182		225	832	624					
	LL	Longline ALB											178			1293									1151	3250	3745		8352	1592	827	2162	1844	1294	3044	559
		Longline Byc				87	162			92	856	1148	60	505	2367	2123	146													1	21	48		74	12	8
	PS	Others											95																							
	TR	Surface gears			85																															717
EU.Greece	LL	Longline ALB																		198	341	549													246	35
		Longline Byc																												21	9955					
	UN	Others			867	379		639																												
EU.Italy	GN	Surface gears								29	119		651				395	791		306		116														
	LL	Longline ALB							679			808						1009	1180	170	282	1272	701	278	3079	2163	2481	514	399	72	638	169	59		316	
		Longline Byc																																149		45
	PS	Others																	53			100														
	UN	Others		601	633	582	503	508												367	133	396	200													
EU.Malta	LL	Longline Byc																																2		11
	TR	Surface gears																													1					
Turkey	GN	Surface gears																									155	1993								
	LL	Longline Byc																																	94	159

Figure 5. Summary of the number of size samples available by year, flag, and gear type. Shade colors indicate the percentile of the number of size samples, with reds corresponding to the low 10% percentile, yellow the 50% percentile, and green the 90% percentile and above.

Figure 6. Distribution of catch (Task 1NC) by main gear type for the Mediterranean albacore.

Distributions

Mean	Geometric Mean	Variance	Std Dev	CV	Kurtosis	Skewness

Mean — Quantiles

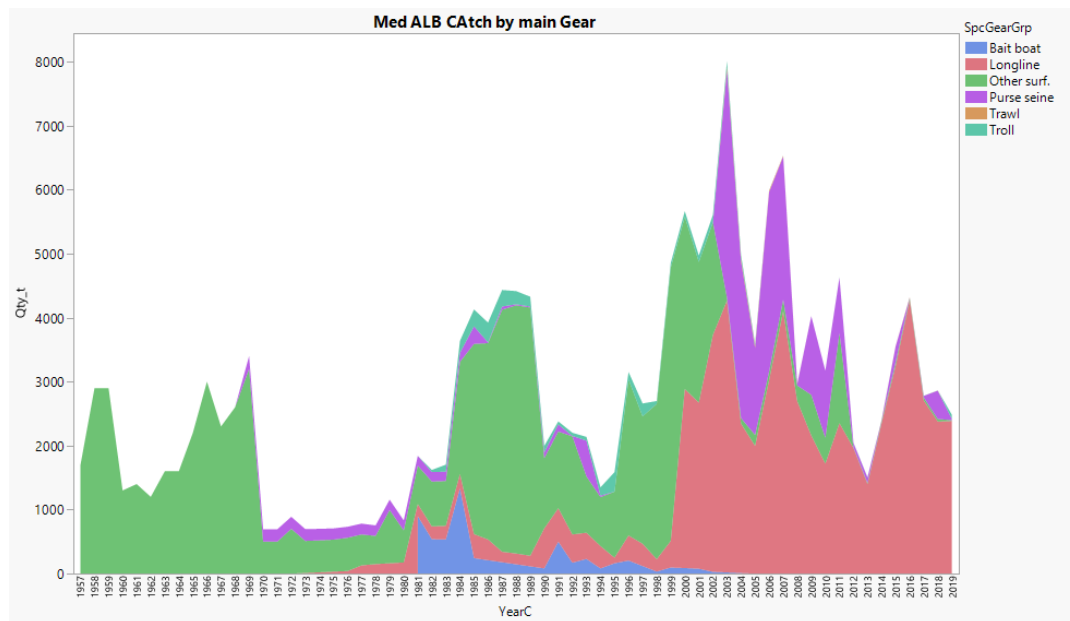|		
100.0%	maximum	135
99.5%		132.055
97.5%		96.2625
90.0%		85.527931034
75.0%	quartile	78.766393443
50.0%	median	74.187077412
25.0%	quartile	69.975830816
10.0%		65.366524815
2.5%		60.5
0.5%		44.263541667
0.0%	minimum	43.333333333

Mean — Summary Statistics

Mean	75.260653
Std Dev	9.1543479
Std Err Mean	0.6200107
Upper 95% Mean	76.482667
Lower 95% Mean	74.038639
N	218

Geometric Mean — Quantiles

100.0%	maximum	129.58148262
99.5%		127.15124177
97.5%		95.208380122
90.0%		85.314421321
75.0%	quartile	78.489434334
50.0%	median	73.834615587
25.0%	quartile	69.476666358
10.0%		65.01332405
2.5%		57.51642435
0.5%		44.110342129
0.0%	minimum	43.267487109

Geometric Mean — Summary Statistics

Mean	74.67173
Std Dev	9.1254781
Std Err Mean	0.6180554
Upper 95% Mean	75.88989
Lower 95% Mean	73.45357
N	218

Variance — Quantiles

100.0%	maximum	1500.4
99.5%		1477.945
97.5%		523.34451324
90.0%		202.30980602
75.0%	quartile	86.144267707
50.0%	median	54.209569646
25.0%	quartile	26.716509729
10.0%		14.439518302
2.5%		0.326260407
0.5%		0
0.0%	minimum	0

Variance — Summary Statistics

Mean	91.939888
Std Dev	159.25936
Std Err Mean	10.886746
Upper 95% Mean	113.39945
Lower 95% Mean	70.480327
N	214

Std Dev — Quantiles

100.0%	maximum	38.734997096
99.5%		38.429030831
97.5%		22.838728295
90.0%		14.222364353
75.0%	quartile	9.2813793145
50.0%	median	7.3626629275
25.0%	quartile	5.168794191
10.0%		3.7999235862
2.5%		0.5596565613
0.5%		0
0.0%	minimum	0

Std Dev — Summary Statistics

Mean	8.1297676
Std Dev	5.0958917
Std Err Mean	0.348348
Upper 95% Mean	8.8164186
Lower 95% Mean	7.4431167
N	214

CV — Quantiles

100.0%	maximum	39.310659755
99.5%		39.014562843
97.5%		28.528194426
90.0%		18.712693614
75.0%	quartile	12.542263934
50.0%	median	10.02009593
25.0%	quartile	6.9170267443
10.0%		4.7122819781
2.5%		0.8172680282
0.5%		0
0.0%	minimum	0

CV — Summary Statistics

Mean	10.826676
Std Dev	6.255792
Std Err Mean	0.4276371
Upper 95% Mean	11.669619
Lower 95% Mean	9.983733
N	214

Kurtosis — Quantiles

100.0%	maximum	40.403911565
99.5%		40.398945551
97.5%		20.740351459
90.0%		4.2468126335
75.0%	quartile	1.3086766917
50.0%	median	0.1554327772
25.0%	quartile	-0.652391226
10.0%		-1.453138549
2.5%		-3.305009208
0.5%		-6.245
0.0%	minimum	-6.25

Kurtosis — Summary Statistics

Mean	1.2701744
Std Dev	5.4282296
Std Err Mean	0.380987
Upper 95% Mean	2.021396
Lower 95% Mean	0.5189528
N	203

Skewness — Quantiles

100.0%	maximum	6.4392993338
99.5%		6.3718290887
97.5%		2.8336597609
90.0%		1.229777869
75.0%	quartile	0.6568218259
50.0%	median	0.1413621751
25.0%	quartile	-0.168141248
10.0%		-0.792834556
2.5%		-1.711399161
0.5%		-2.832513169
0.0%	minimum	-2.865143572

Skewness — Summary Statistics

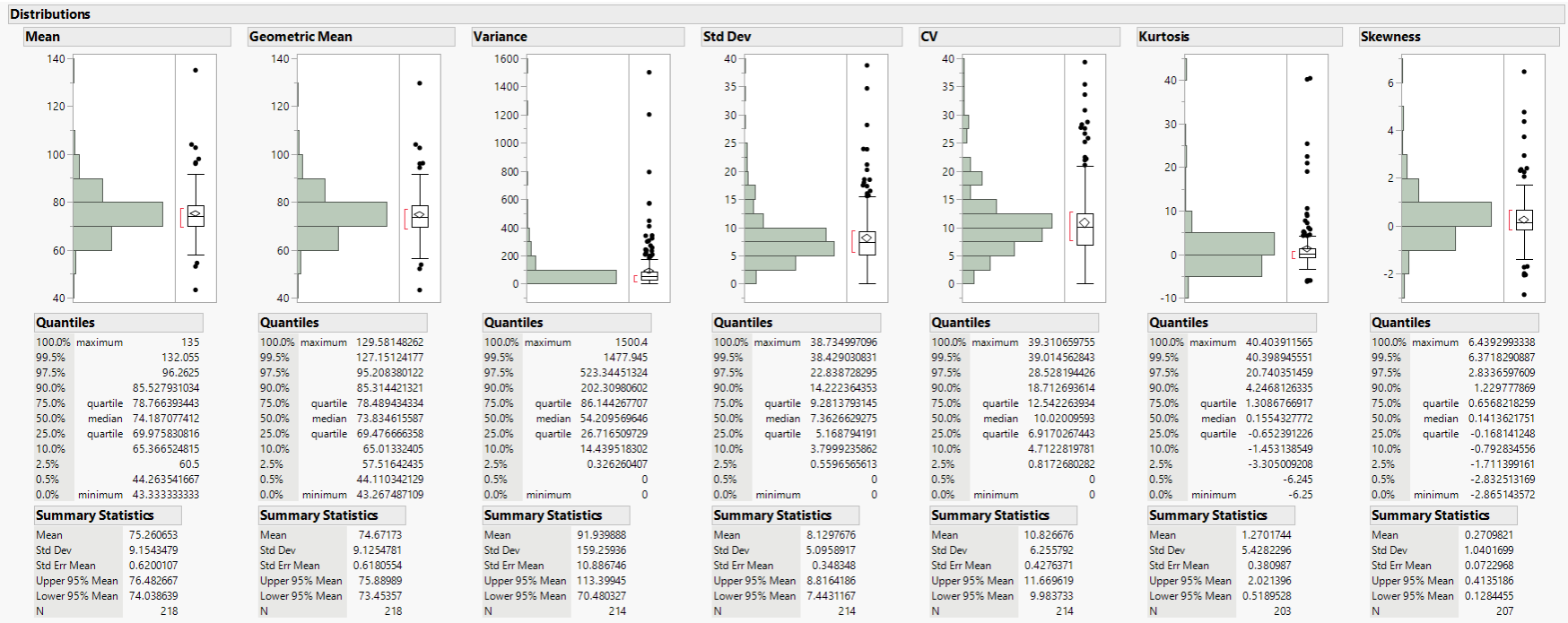|	
Mean	0.2709821
Std Dev	1.0401699
Std Err Mean	0.0722968
Upper 95% Mean	0.4135186
Lower 95% Mean	0.1284455
N	207

Figure 7. Mediterranean albacore summary of central tendency and other statistics indicator distributions from the available size-frequency samples
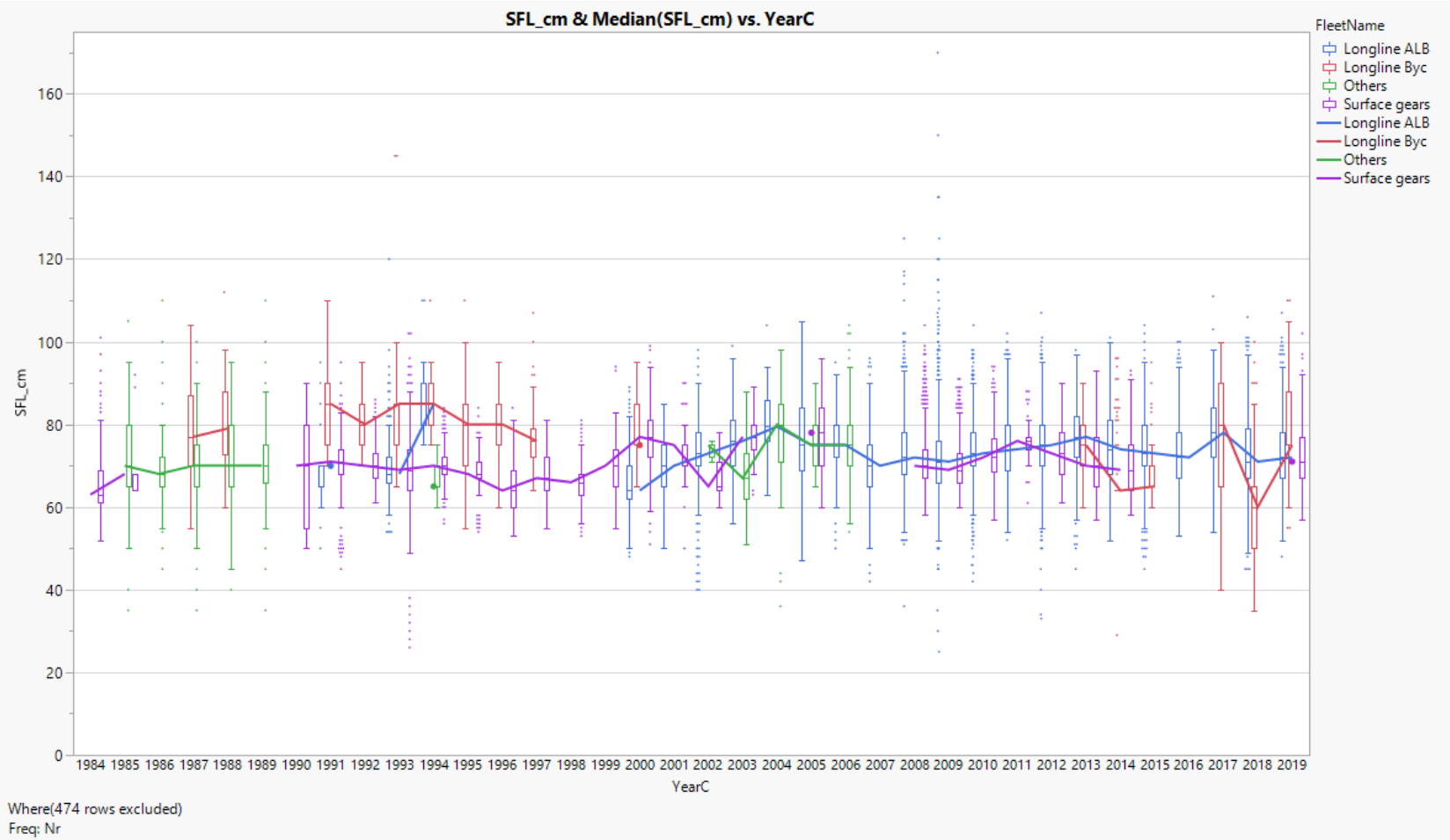
Figure 8. Mediterranean albacore size distribution annual trends for the main gear/fleets of the size-frequency samples. Lines represent the median of the year distributions.
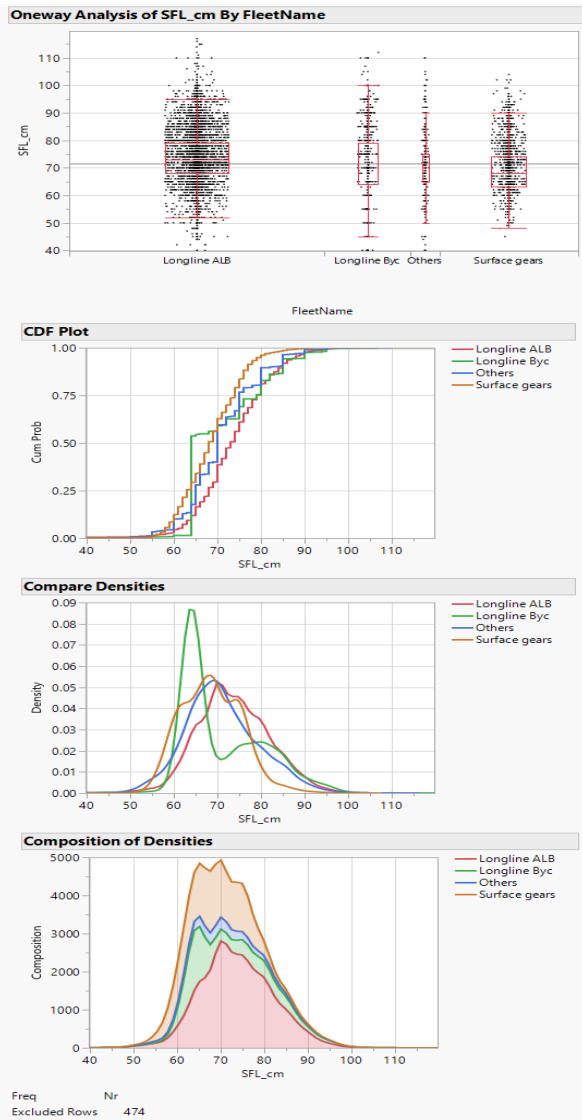
Figure 9. Distribution of Albacore size-frequency samples by main gear/fleets. In the boxplot (top), the width is proportional to the size sample number, other plots include cumulative density plot, densities, and composition densities.
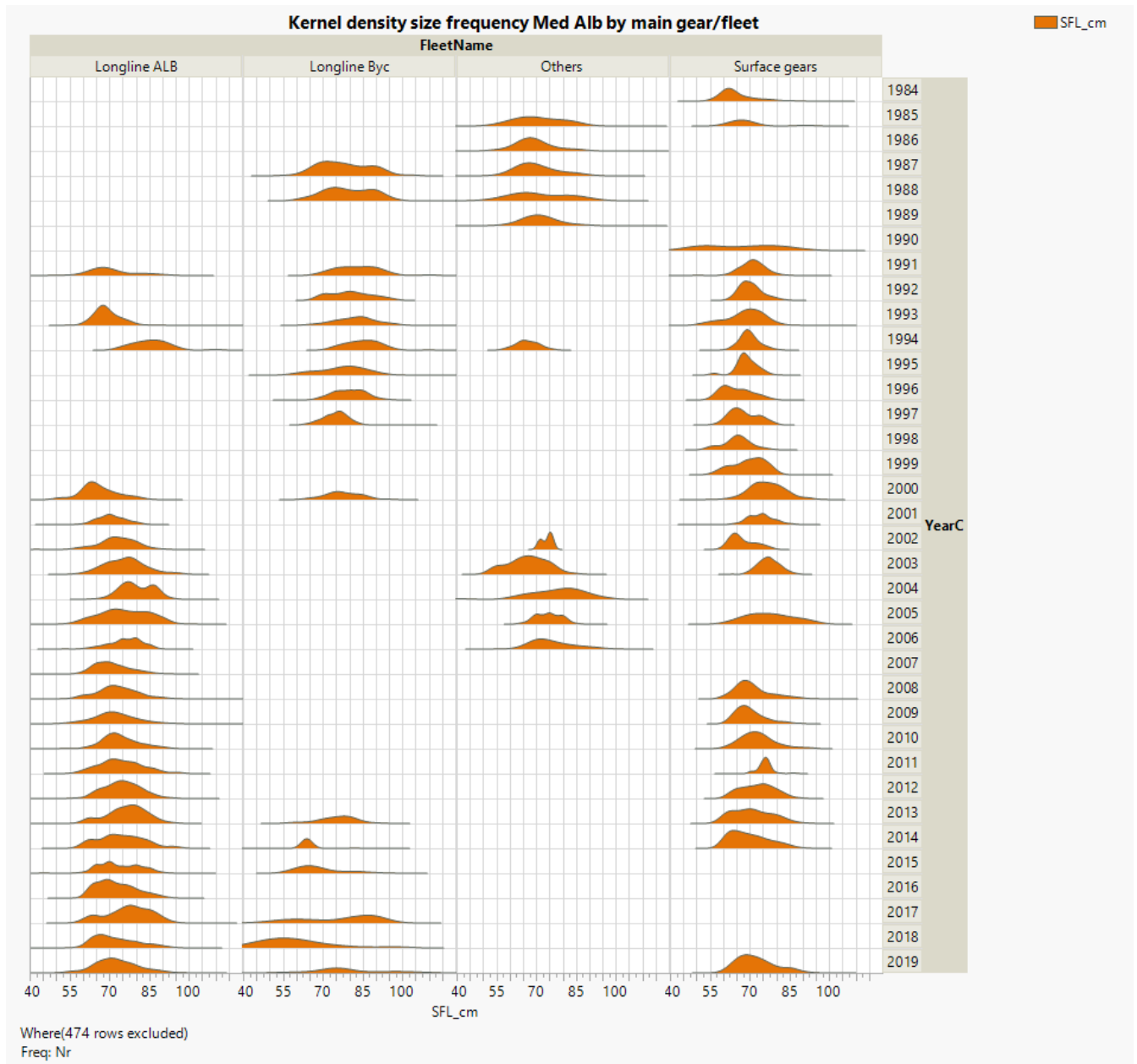
Figure 10. Kernel density size distributions for Mediterranean albacore size-frequency samples by main gear/fleet and year.