

## UPDATED FISHERY STATISTICS OF TUNA SPECIES CAUGHT OFF MADEIRA ARCHIPELAGO

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### SUMMARY

*Tunas are an important fisheries resource which occurs seasonally in the waters of Madeira archipelago. Both Madeiran and Azorean fleets operate in the region, with the Azorean fleet having a higher proportion of landings in recent years. Since 2015, most fishing events have concentrated in Madeira EEZ, especially near the islands. Bigeye tuna is the most important species with consistent landings between years. Since 2014, albacore has been the second most landed species, overtaking skipjack. Recent data on bluefin are also presented, although landings are quite restricted due to regulations applied as part of the ongoing recovery plan for this species. Seasonality and length composition of landings of the main tuna species for the period 2010 – 2017 are also presented.*

### RÉSUMÉ

*Les thonidés sont une ressource halieutique importante que l'on rencontre de façon saisonnière dans les eaux de l'archipel de Madère. Les deux flottilles madériennes et açoriennes opèrent dans la région, la flottille des Açores ayant une proportion plus élevée de débarquements ces dernières années. Depuis 2015, la plupart des activités de pêche se concentrent dans la ZEE de Madère, en particulier près des îles. Le thon obèse est l'espèce la plus importante avec des débarquements réguliers d'une année à l'autre. Depuis 2014, le germon est la deuxième espèce la plus débarquée, dépassant le listao. Des données récentes sur le thon rouge sont également présentées, bien que les débarquements soient assez restreints en raison des réglementations appliquées dans le cadre du plan de rétablissement en cours pour cette espèce. La saisonnalité et la composition par taille des débarquements des principales espèces de thonidés pour la période 2010-2017 sont également présentées.*

### RESUMEN

*Los túnidos son un importante recurso pesquero que está presente estacionalmente en aguas del archipiélago de Madeira. Tanto la flota de Madeira como la de Azores operan en la región, y la flota de Azores cuenta con una proporción mayor de desembarques en años recientes. Desde 2015, la mayoría de las operaciones de pesca se han concentrado en la ZEE de Madeira, especialmente cerca de las islas. El patudo es la especie más importante, con desembarques constantes entre los años. Desde 2014, el atún blanco ha sido la segunda especie más desembarcada, sobrepasando al listado. También se presentan datos recientes sobre atún rojo, aunque los desembarques están bastante restringidos debido a las reglamentaciones aplicadas como parte del plan de recuperación en vigor para esta especie. Se presentan también la estacionalidad y la composición por tallas de los desembarques de las principales especies de túnidos para el periodo 2010-2017.*

### KEYWORDS

*Fishery statistics, Madeira, tuna, bigeye, albacore, skipjack, bluefin*

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## 1. Introduction

Tunas are a very important resource for fisheries in Madeira archipelago, usually caught by bait boats, using pole and line, a highly selective fishing method with low impact on the ecosystem. Tuna catches in the region often reach, and sometimes exceed, half of the total landings in the region (Hermida and Delgado 2016). Bigeye tuna (*Thunnus obesus*) and skipjack (*Katsuwonus pelamis*), two tropical tuna species, are usually the most common species in Madeira, but occasionally albacore (*Thunnus alalunga*) surpasses them. In fact, albacore was the second most fished species (after bigeye) in the period 2014-2017.

Atlantic bluefin tuna (*Thunnus thynnus*) also occurs in the region, but fishing of this species was forbidden for several years, due to the multi-annual ICCAT recovery plan for this species in the eastern Atlantic and Mediterranean. In addition, there are some occasional catches of yellowfin (*Thunnus albacares*), but these are sporadic and limited to warmer periods.

The main fishing method used in Madeira is the pole-and-line, using small pelagic fish such as mackerel as live bait. In the case of bigeye and sometimes skipjack, it is now a common practice for the fishermen to use the boats themselves as temporary fish aggregating devices, a practice known locally as “mancha”. A recent development is the introduction of small longlines (up to 250 hooks) in this fishery, which are used especially in the beginning and end of the season, directed at larger specimens that occur at greater depths.

In this study, we present updated statistics on tuna catches by the Madeiran and Azorean tuna fishing fleets operating in Madeira waters, for the four main species. We include recent data for bluefin tuna since 2016, when a limited amount of by-catch of this species started to be permitted. Recently, fishermen have reported an increase in the occurrence of this species in the area, which could constitute a sign that the recovery plan has worked and that the bluefin population is showing signs of recovery.

## 2. Data

The data presented in this article include tuna landings in Madeira fishing ports, carried out by both Madeiran and Azorean tuna fishing fleets, for the period 1999-2017. Landings data for the four most important tuna species were included (bigeye, albacore, skipjack, and bluefin).

Information on the fleet composition (number of vessels and GT) was obtained from the national fleet register database for the period 2010-2017.

Size composition data for the period 2010-2017 are based on statistical sampling of specimens landed in the main fishing ports in the island of Madeira. In the study period, a total of 33 901 bigeye, 12 049 albacore, 14 910 skipjack and 30 bluefin tuna individuals were sampled at port.

Spatial locations of the tuna fishing grounds were obtained from fishing logbooks of the Madeiran tuna fishing fleet and processed using QGIS 2.2. software. Two distinct periods were considered for comparison, the first from 2010 to 2014 and the second from 2015 to 2017.

Sea surface temperature data was extracted from the meteorological records of the Meteorological Observatory of Funchal, for the period 1960 to 2017.

## 3. Results and Discussion

Landings of the main tuna species in Madeira exhibit high fluctuations (Gouveia and Mejuto 2003), which is consistent with the dependence of tunas on environmental and biological variables which tend to vary between years (**Table 1, Figure 1**). Nevertheless, total tuna landings show some stability in recent years, despite large fluctuations of the individual species (Gouveia *et al.*, 2017). Albacore landings are the most variable, with much higher landing since 2014 than in previous years. Bigeye tuna is the most consistent species between years, while skipjack is highly unpredictable. It is early to draw conclusions in relation to bluefin tuna, since limited landings of this species have only been resumed in 2016, and only as by-catch, during the multi-annual ICCAT recovery plan for this species, but there seems to be an increasing tendency, which is consistent with anecdotal reports by fishermen, who have noticed a more frequent occurrence of this species recently.

The relative weight of each fishing fleet in the landings of the main tuna species in Madeira is presented in Figure 2, where the dominance by the Azorean fleet is evident, reflecting its higher capacity. The regional tuna fleet composition, classified by gross tonnage, is presented in **Table 2** and **Figure 3**.

The three main tuna species landed in Madeira present characteristic seasonal patterns of occurrence (**Figure 4**). In the study period, bigeye presented a peak in catches during the spring, and declining but still significant catches until the end of summer, while skipjack usually appeared later and presented peaks in late summer and early autumn, typically coinciding with warmer water temperatures. Albacore was mostly caught in the spring, sometimes also extending into the summer months.

Length composition of the main tuna species was estimated for the total landings based on statistical sampling at port (**Tables 3 a, b, c; Figures 5 a, b, c**). For bigeye, there seems to be a slight increase in the frequency of small to medium-sized specimens, while for albacore, a higher frequency of larger specimens can be observed in recent years. Skipjack sizes show no clear trend in the study period. Concerning bluefin tuna, although landings are low, the specimens landed are quite large (**Figure 5d**), which could reflect the fishing gears used (longline, handline), as well as the regulations which stipulate that they can only be landed as a 5% by-catch of other tuna species.

In the period between 2010 and 2014 (**Figure 6a**) it is visible that there were important fleet displacements between Madeira and Azores, while in the more recent time period between 2015 and 2017 (**Figure 6b**), fishing has concentrated mainly within the Madeiran EEZ, with most fishing events happening around Madeira, Desertas, Porto Santo, near the Selvagens islands, and rarely in the Azores area.

The annual average of Sea Surface Temperature (SST) anomalies is presented for the period 1960-2017, as an environmental indicator (**Figure 7**). Despite the inter-annual variability, a clear warming trend is observed since the 1990s. This warming tendency is likely to have impacts on the distribution and migratory behaviour of numerous marine species, including tunas (Arrizabalaga *et al.*, 2015).

## **Acknowledgements**

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## References

- Arrizabalaga, H., Dufour, F., Kell, L., Merino, G., Ibaibarriaga, L., Chust, G., Irigoien, X., Santiago, J., Murua, H., Fraile, I., Chifflet, M., Goikoetxea, N., Sagarminaga, Y., Aumont, O., Bopp, L., Herrera, M., Fromentin, J. M., and Bonhommeau, S. 2015. Global habitat preferences of commercially valuable tuna. *Deep-Sea Research II* 113, 102–112.
- Gouveia, L., and Mejuto, J. 2003. Seasonality and interannual variability in catches of skipjack tuna (*Katsuwonus pelamis*) and bigeye tuna (*Thunnus obesus*) in the area around the archipelago of Madeira. *Collect. Vol. Sci. Pap. ICCAT*, 55(5), 1853-1867.
- Gouveia, L., Amorim, A., Alves, A., & Hermida, M. 2017. Updated fishery statistics for bigeye, skipjack and albacore tunas from Madeira archipelago. *Collect. Vol. Sci. Pap. ICCAT*, 73(4), 1547-1560.
- Hermida, M., & Delgado, J. 2016. High trophic level and low diversity: Would Madeira benefit from fishing down? *Marine Policy*, 73, 130-137.

**Table 1.** Landings of the main tuna species in Madeira, in tones, for period 1999-2017.

<b>YEAR</b>	<b>BET</b>	<b>SKJ</b>	<b>ALB</b>	<b>BFT</b>	<b>OTH</b>	<b>TOTAL</b>
<b>1999</b>	1107	345	78	3	41	1575
<b>2000</b>	384	262	14	1	31	692
<b>2001</b>	276	495	765	2	36	1574
<b>2002</b>	759	556	1479	7	18	2819
<b>2003</b>	883	587	333	1	16	1820
<b>2004</b>	1227	1595	104	6	17	2949
<b>2005</b>	977	1094	63	5	26	2164
<b>2006</b>	2082	1713	3	7	17	3822
<b>2007</b>	2321	504	25		16	2866
<b>2008</b>	1400	912	111		9	2431
<b>2009</b>	2405	104	9		7	2525
<b>2010</b>	1118	686	40		16	1860
<b>2011</b>	1020	299	13		36	1369
<b>2012</b>	1576	1537	21		22	3157
<b>2013</b>	1241	210	151		10	1612
<b>2014</b>	1667	962	2264		12	4905
<b>2015</b>	1773	117	864		7	2761
<b>2016</b>	1564	43	1093	6*	18	2724
<b>2017</b>	2252	673	2194	17*	21	5157

\* By-catch of other tuna species.

**Table 2.** Fishing tuna fleet composition by gross tonnage, 2010-2017.

<i>Year</i>	<i>GT</i>	<i>Madeiran Fleet</i>		<i>Azorean Fleet</i>	
		<i>Nr. Boats</i>	<i>Landings (t)</i>	<i>Nr. Boats</i>	<i>Landings (t)</i>
2010	<50	68	303	1	22
	[50-150]	5	89	10	876
	>150	3	462	3	93
2011	<50	62	410	1	22
	[50-150]	5	241	9	343
	>150	3	336	1	16
2012	<50	49	1043	2	59
	[50-150]	4	588	10	776
	>150	3	637	2	53
2013	<50	53	538	1	33
	[50-150]	4	205	13	514
	>150	3	278	3	43
2014	<50	46	630	4	149
	[50-150]	4	512	17	2628
	>150	3	652	3	333
2015	<50	60	364	3	67
	[50-150]	5	348	16	1490
	>150	3	246	3	225
2016	<50	57	457	2	9
	[50-150]	6	363	17	1465
	>150	3	183	3	245
2017	<50	62	714	5	169
	[50-150]	6	751	19	2957
	>150	1	161	3	406

**Table 3a.** Size composition of bigeye tuna landed in Madeira, 2010-2017.

<b>FL(5-5cm)</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
<b>40</b>	225	0	0	0	0	703	30	30
<b>45</b>	1985	26	43	24	0	634	15	375
<b>50</b>	3387	291	808	361	1026	2364	293	1519
<b>55</b>	4900	1133	1822	758	2339	8089	1079	2904
<b>60</b>	5923	1920	3128	422	2524	11577	5318	7833
<b>65</b>	4180	1930	3091	443	1675	6167	6108	6787
<b>70</b>	8124	1931	6164	3313	2831	6156	12983	11927
<b>75</b>	8346	2124	12634	4264	4217	7085	11393	11782
<b>80</b>	3931	1561	22252	3764	4509	7531	10928	13590
<b>85</b>	1404	1591	13578	1467	2731	4748	5261	8079
<b>90</b>	2567	2003	11235	914	3543	4154	4925	8699
<b>95</b>	2337	2328	7352	1410	5456	5221	3812	8028
<b>100</b>	2125	2404	5648	2302	7855	6283	4126	8325
<b>105</b>	2388	2875	2531	2118	6181	3945	2461	6252
<b>110</b>	3133	3813	2334	2912	6319	4855	3323	6814
<b>115</b>	2429	2784	1227	2513	2878	3485	2794	3833
<b>120</b>	2086	2214	1211	1559	2921	3667	3190	3248
<b>125</b>	1495	1277	1017	840	2888	3188	1693	2111
<b>130</b>	1195	974	1654	833	2880	2691	1663	1427
<b>135</b>	503	674	625	619	1978	1344	914	1106
<b>140</b>	519	564	346	891	1043	948	776	660
<b>145</b>	260	433	165	1131	506	387	560	457
<b>150</b>	214	555	77	1954	462	203	494	593
<b>155</b>	369	442	51	609	112	60	336	488
<b>160</b>	188	422	1	1037	71	79	291	333
<b>165</b>	314	325	1	605	100	156	191	398
<b>170</b>	282	370	7	606	43	160	145	307
<b>175</b>	47	68	5	302	41	2	105	325
<b>180</b>	49	26	38	94	13	56	94	115
<b>185</b>	1	0	36	63	0	26	11	3
<b>190</b>	1	10	0	0	52	0	0	20
<b>195</b>	0	0	0	0	56	0	0	0
<b>200</b>	0	0	0	0	0	0	0	0
Total No.	64909	37066	99081	38131	67251	95963	85311	118365
Total Landings (t)	1105	1019	1576	1241	1667	1752	1564	2252
Average Weight (Kg)	17	28	16	33	25	18	18	19

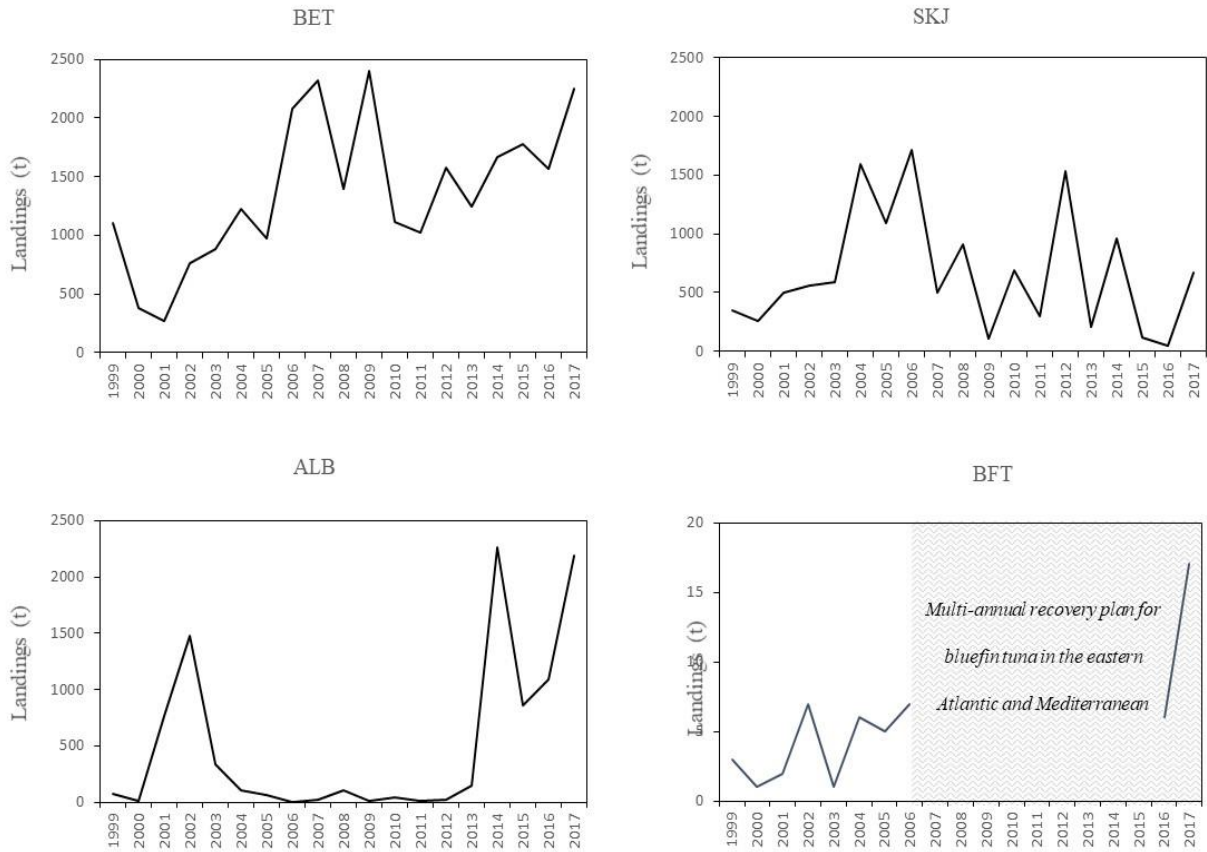
**Table 3b.** Size composition of skipjack landed in Madeira, 2010-2017.

<i>FL(2-2cm)</i>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
<b>30</b>	0	0	0	0	0	0	0	347
<b>32</b>	27	5	61	0	78	0	0	106
<b>34</b>	27	5	95	1	151	164	10	636
<b>36</b>	106	20	570	3	788	189	14	1791
<b>38</b>	1451	39	1159	7	1702	728	308	8213
<b>40</b>	9922	575	4581	28	5848	1815	491	26555
<b>42</b>	18058	5369	14059	85	11692	8050	2035	26495
<b>44</b>	25441	11399	26832	302	14840	11525	2412	41732
<b>46</b>	39772	10215	49285	1980	33067	10659	4169	51933
<b>48</b>	38138	22189	84008	4235	48989	7235	3417	40006
<b>50</b>	27596	14294	80567	7148	47329	6519	3385	36901
<b>52</b>	24471	15253	75455	8814	39646	3257	1453	25704
<b>54</b>	18853	8877	75010	11176	33791	2096	809	13460
<b>56</b>	13911	6030	54106	8798	27044	1385	383	7859
<b>58</b>	8470	2917	32122	5181	19045	509	242	5846
<b>60</b>	8321	1893	18060	3722	13825	160	93	4575
<b>62</b>	4760	1995	7707	2263	10323	264	59	2426
<b>64</b>	5299	1495	4151	1721	5666	32	1	1031
<b>66</b>	2415	623	564	701	5173	85	4	925
<b>68</b>	2823	1308	551	814	1032	16	1	405
<b>70</b>	1146	1186	167	350	745	16	1	283
<b>72</b>	369	381	217	463	73	0	0	0
<b>74</b>	0	61	0	350	187	16	1	218
<b>76</b>	0	0	0	0	156	0	0	0
<b>78</b>	0	0	0	88	0	0	0	65
<b>80</b>	0	0	0	0	0	0	0	185
<b>82</b>	0	0	0	0	0	0	0	0
<b>84</b>	0	0	0	0	0	0	0	0
<b>86</b>	0	61	0	0	0	0	0	0
<b>88</b>	0	0	0	0	0	0	0	0
<b>90</b>	0	0	0	0	0	0	0	0
	<b>251</b>							
<b>Total No.</b>	<b>376</b>	<b>106 187</b>	<b>529 324</b>	<b>58 231</b>	<b>321 190</b>	<b>54 720</b>	<b>19 288</b>	<b>297 699</b>
<b>Total Landings (t)</b>	<b>685</b>	<b>299</b>	<b>1537</b>	<b>209</b>	<b>962</b>	<b>117</b>	<b>43</b>	<b>673</b>
<b>Average Weight (Kg)</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>

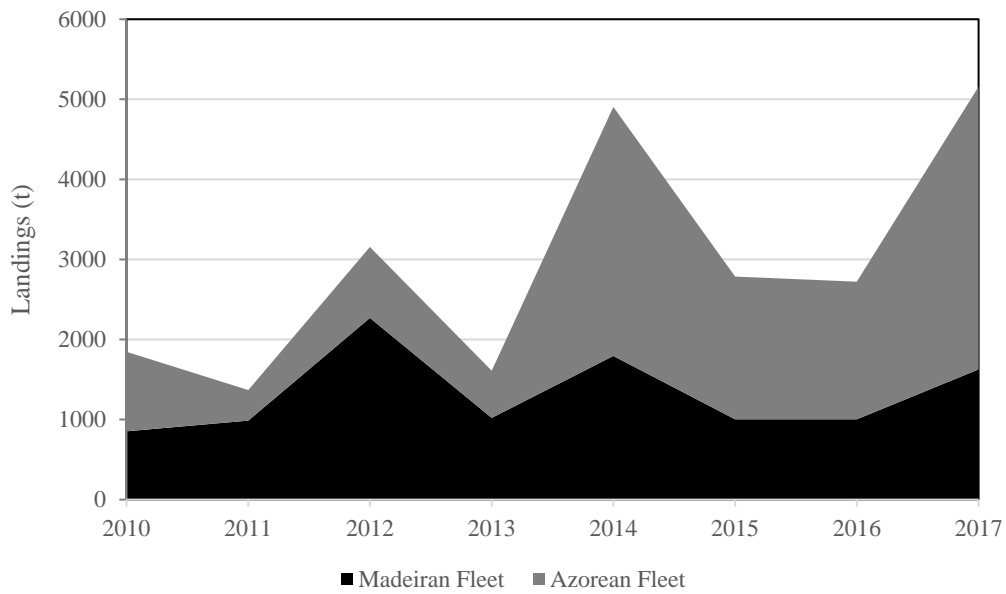


**Table 3c.** Size composition of albacore tuna landed in Madeira, 2010-2017.

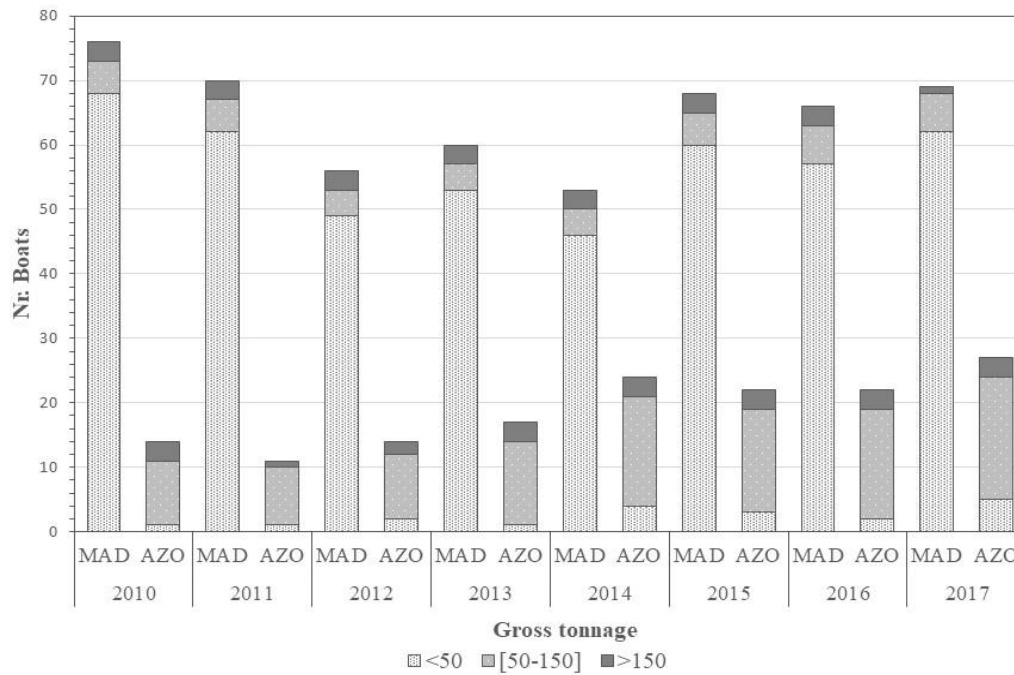
<b>FL(5-5cm)</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
<b>40</b>	0	0	0	0	0	0	0	0
<b>45</b>	0	0	0	0	0	0	0	0
<b>50</b>	0	0	41	6	426	45	154	0
<b>55</b>	10	5	62	97	778	409	115	58
<b>60</b>	132	79	103	15	2206	772	192	46
<b>65</b>	42	16	21	3	2407	2150	442	15
<b>70</b>	90	10	23	307	16585	14435	1846	882
<b>75</b>	347	5	235	2042	60970	27752	3526	3068
<b>80</b>	682	101	403	5087	86509	21673	24439	19171
<b>85</b>	541	108	168	2370	26515	6985	31699	45564
<b>90</b>	135	59	47	532	4165	2096	12481	55717
<b>95</b>	109	50	49	350	890	702	2170	17574
<b>100</b>	157	78	84	451	303	735	703	2446
<b>105</b>	138	67	70	156	741	666	627	452
<b>110</b>	192	95	136	137	68	171	661	63
<b>115</b>	37	22	24	17	2	217	97	34
<b>120</b>	6	7	0	0	1	183	0	0
<b>125</b>	6	0	0	0	0	92	38	0
<b>130</b>	0	0	0	0	0	0	0	0
<b>135</b>	0	0	0	0	0	0	0	0
<b>140</b>	0	0	0	0	0	1	0	0
<b>145</b>	0	0	0	0	0	0	0	0
<b>Total No.</b>	<b>2 622</b>	<b>703</b>	<b>1 467</b>	<b>11 572</b>	<b>202 566</b>	<b>79 083</b>	<b>79192</b>	<b>145 090</b>
<b>Total Landings (t)</b>	<b>40</b>	<b>13</b>	<b>21</b>	<b>151</b>	<b>2264</b>	<b>864</b>	<b>1093</b>	<b>2194</b>
<b>Average Weight (kg)</b>	<b>15</b>	<b>18</b>	<b>14</b>	<b>13</b>	<b>11</b>	<b>11</b>	<b>14</b>	<b>15</b>



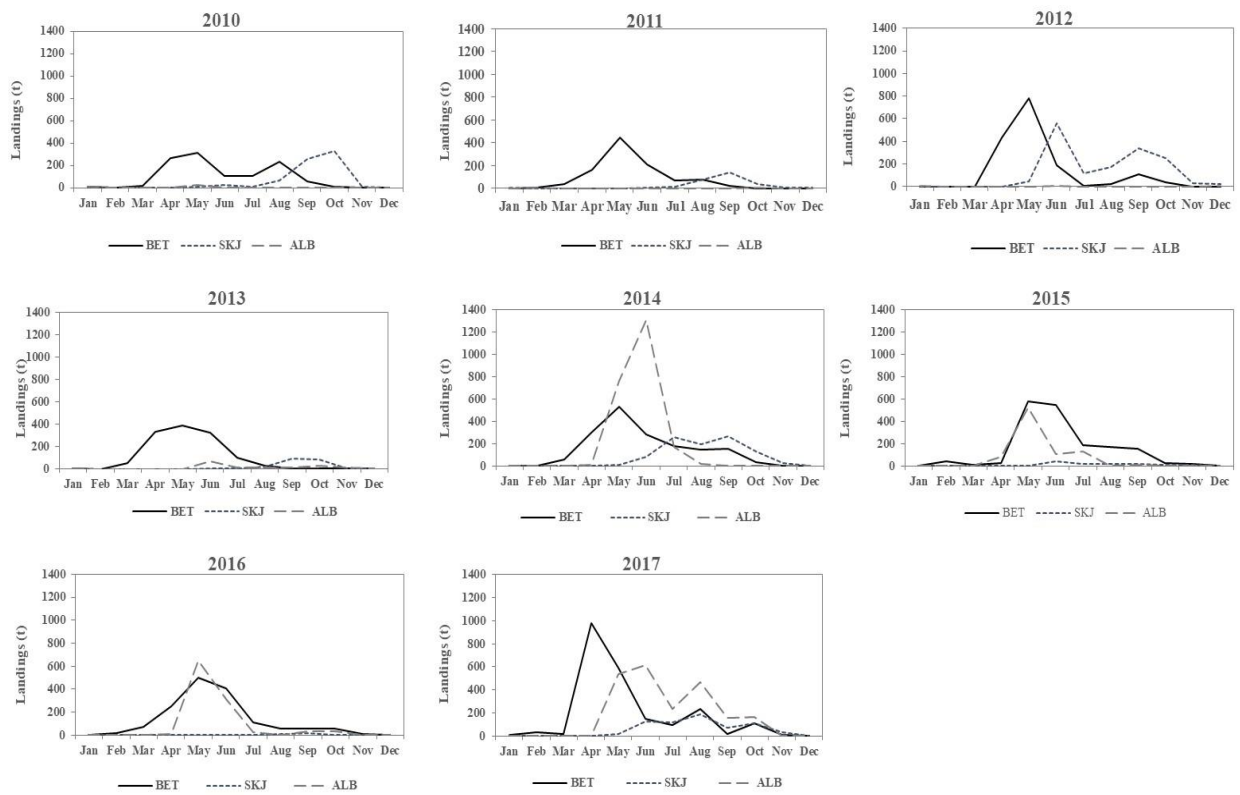
**Figure 1.** Landings of bigeye, skipjack, albacore, and bluefin in the Madeira EEZ, 1999-2017.



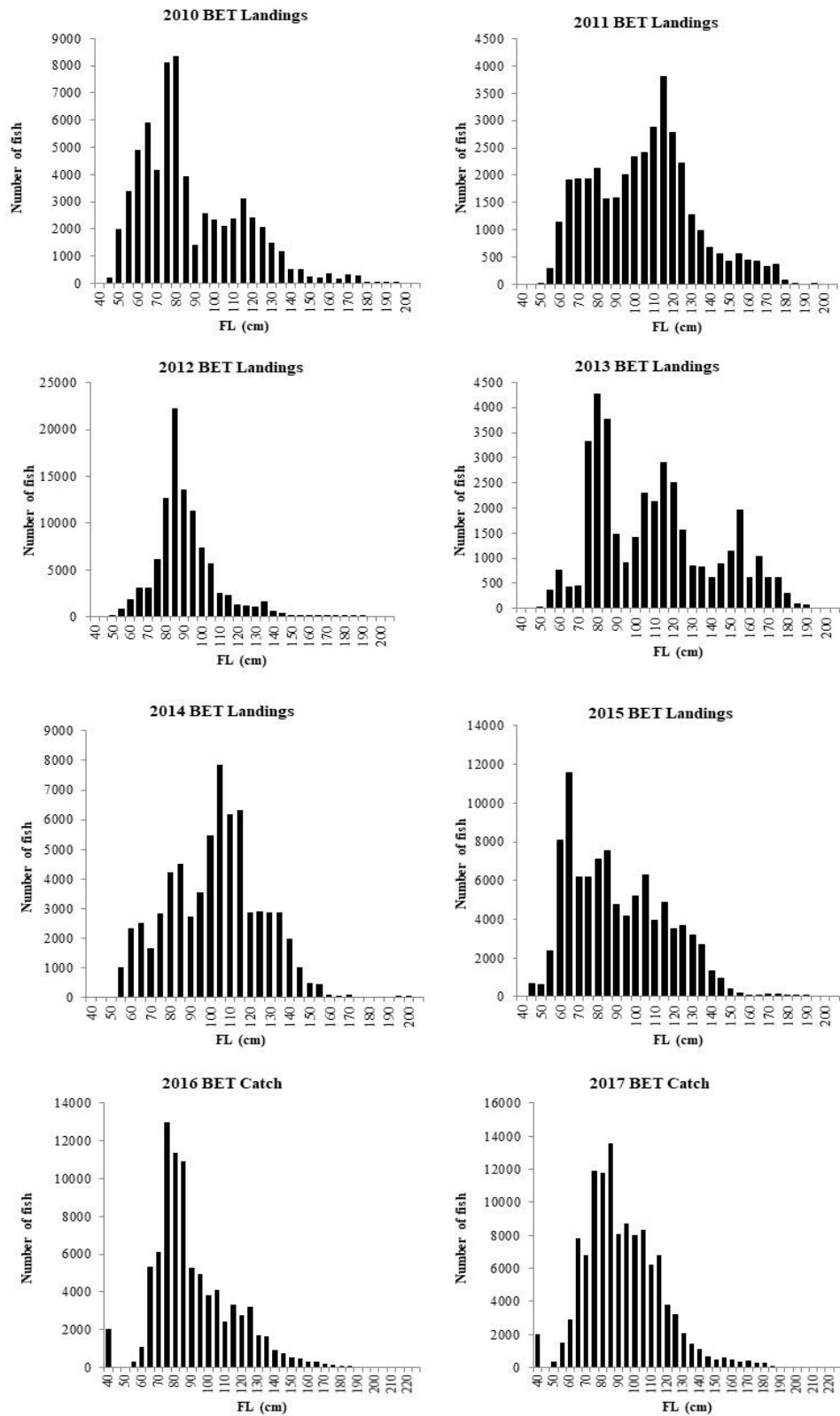
**Figure 2.** Landings of the major tuna species in Madeira, by fleet, 2010-2017.



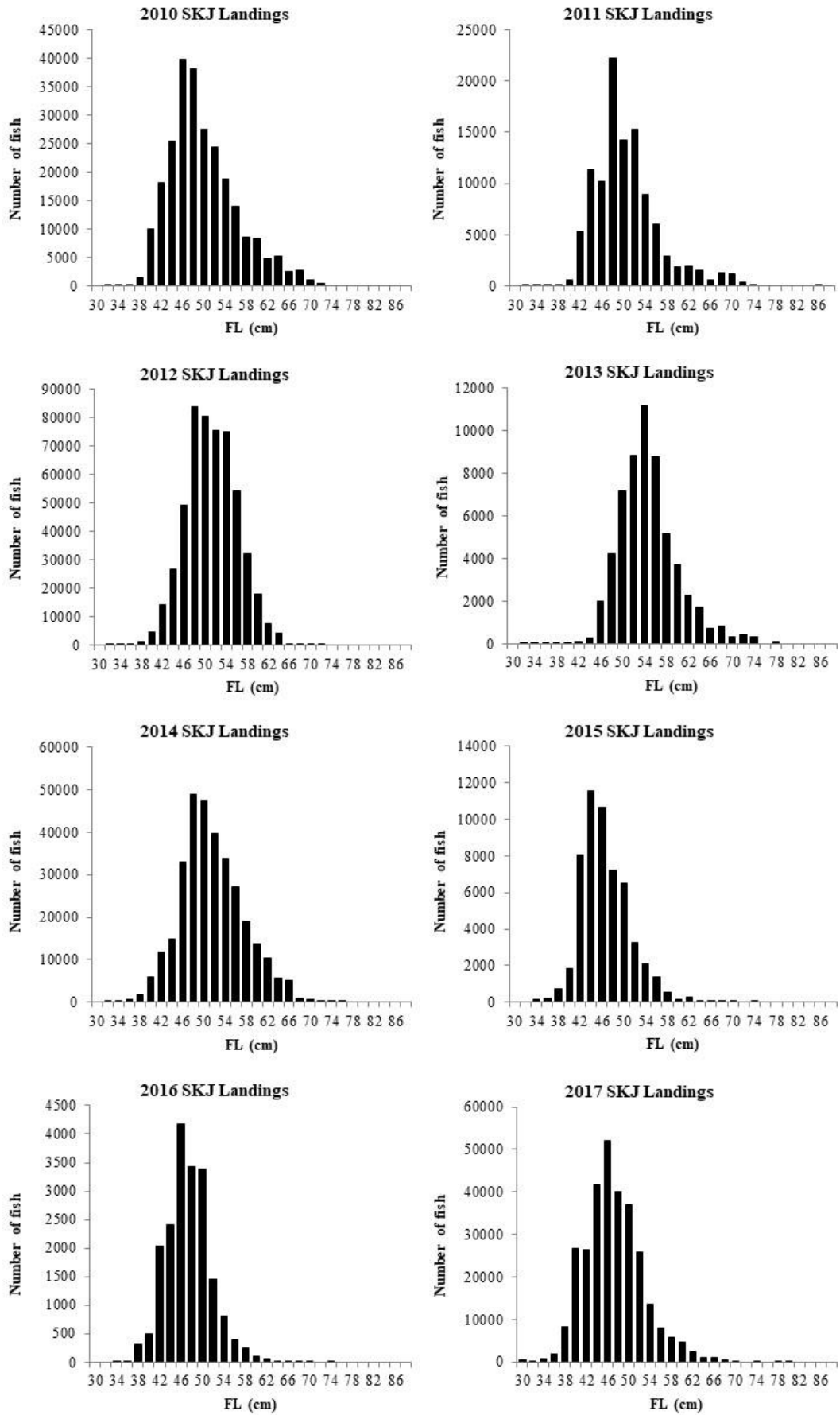
**Figure 3.** Fishing tuna fleet composition by gross tonnage, 2010-2017. MAD- Madeiran fleet, AZO- Azorean fleet.



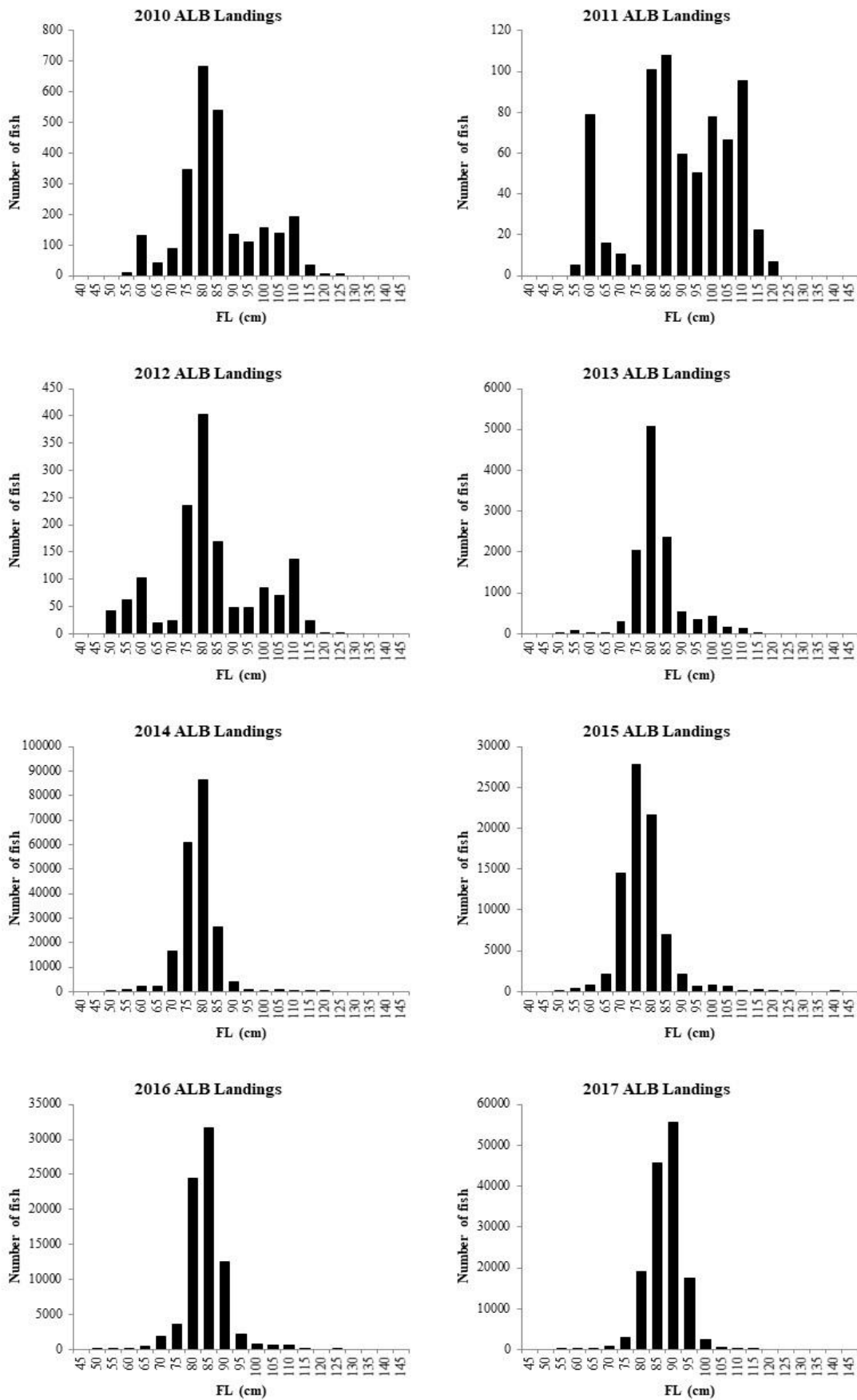
**Figure 4.** Landings seasonality for the main tuna species (BET, SKJ, ALB) in Madeira, 2010-2017.



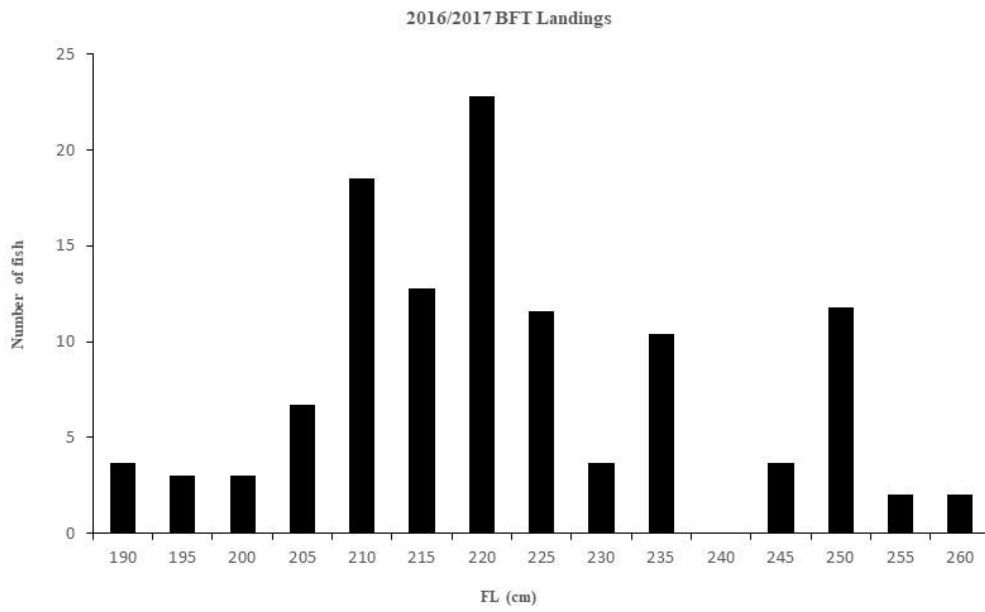
**Figure 5a.** Estimated length composition of bigeye tuna landed in Madeira, 2010-2017.



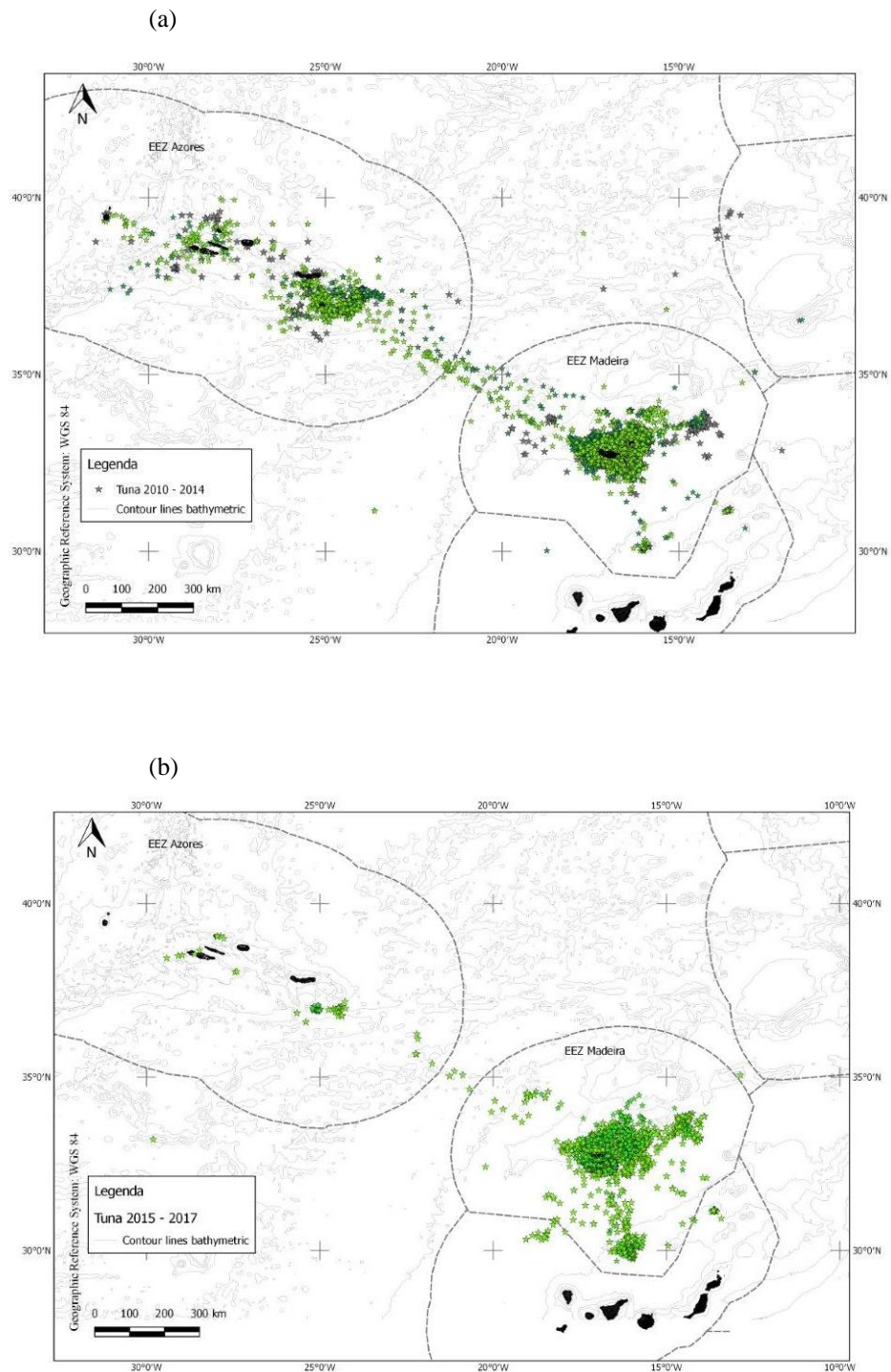
**Figure 5b.** Estimated length composition of skipjack landed in Madeira, 2010-2017.



**Figure 5c.** Estimated length composition of albacore landed in Madeira, 2010-2017.

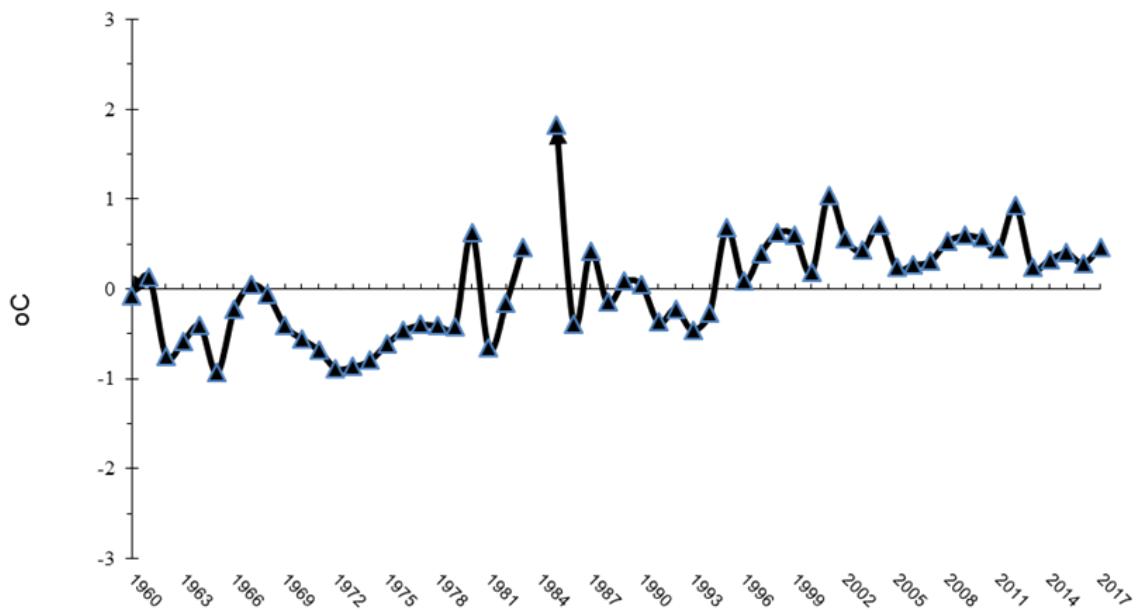


**Figure 5d.** Estimated length composition of bluefin landed in Madeira, 2016-2017.



**Figure 6.** Tuna fishing grounds around Madeira and Azores islands used by the local fleet in the period: (a) 2010-2014; (b) 2015-2017. Data source: Fishing logbooks.





**Figure 7.** Annual average Sea Surface Temperature anomalies (degrees Celsius), Madeira, 1960-2017. Data source: Meteorological records of Observatório Meteorológico do Funchal. <https://drive.google.com/drive/folders/0B5WhYesks4kVHE1Q1lzNUdEY28>