

BLUEFIN TUNA CATCH REVIEW OF THE “BRAZILIAN EPISODE” FOR THE MSE OM ROBUSTNESS TEST

Ai Kimoto¹ and Mauricio Ortiz¹

SUMMARY

The current assumptions for the Atlantic Bluefin tuna catch include within the West stock unit the catches off Brazil in the late 1950's to the early 1960's, commonly known as the “Brazilian episode”. Under the development of the BFT MSE, a robustness test has been requested that proposes that all these catches are assumed to be part of the eastern stock. This document reviews the ICCAT database used in the current OM, and provides the catch at age for the robustness test.

RÉSUMÉ

Les postulats actuels concernant les prises de thon rouge de l'Atlantique incluent dans l'unité de stock de l'Ouest les prises au large du Brésil de la fin des années 50 au début des années 60, communément appelées « période brésilienne ». Dans le cadre du développement de la MSE pour le thon rouge, un test de robustesse a été demandé qui propose de postuler que toutes ces captures font partie du stock oriental. Ce document passe en revue la base de données de l'ICCAT utilisée dans les OM actuels et fournit la prise par âge pour le test de robustesse.

RESUMEN

Los supuestos actuales para la captura de atún rojo del Atlántico incluyen dentro de la unidad de stock occidental las capturas en aguas de Brasil desde finales de los 50 hasta principios de los 60, comúnmente conocidas como el «episodio brasileño». En el marco del desarrollo de una MSE para el atún rojo, se ha solicitado una prueba de robustez que propone que todas estas capturas formen parte del stock oriental. Este documento revisa la base de datos de ICCAT utilizada en los OM actuales y proporciona la captura por edad para la prueba de robustez.

KEYWORDS

Bluefin tuna, western stock, robustness test, OM, catch-at-age

¹ ICCAT Secretariat. Corazón de Maria 8, 28002 Madrid, Spain.

1. Introduction

The current assumptions for the Atlantic Bluefin tuna catch include within the West stock unit the catches off Brazil in the late 1950's to the early 1960's, commonly known as the "Brazilian episode" (Fromentin and Powers, 2006). These catches represented primarily the fishing operations by Japanese longliners off the North-east coast of Brazil in the period between 1962 and 1967, which caught 5000 to 12000 t of bluefin tuna (Takeuchi *et al.*, 2009). A comprehensive analysis of the Japanese fishing effort (Takeuchi *et al.*, 1999) indicated a predominance of Atlantic bluefin between north of 20 latitude south and 15 latitude north (**Figure 1**), but covering a large area of the Tropical waters of the Atlantic at both sides of the stock division line between East and West stocks (**Figure 2**).

This episode rapidly ended and since then relatively limited amounts of bluefin have been caught in the Southwest Atlantic. Several hypotheses have been proposed for the fate of this subpopulation and the reasons for the sudden decline of bluefin tuna in this area.

Under the development of the BFT MSE, the catches of the Brazilian episode are assumed to be fish of western origin in a reference set. A robustness test has been requested that proposes that all these catches are assumed to be part of the eastern stock, and to allocate them from the West Atlantic (OM area 2: WATL) to the East Atlantic (OM area 4 SATL: south of 40N).

This document reviews the ICCAT database used in the current OMs, and provides the dataset for the robustness test.

2. Methods

The ICCAT Secretariat database of catch (Task 1 NC) and catch distribution (Task 2 CE) has been used to estimate historically the catches of bluefin tuna by stock and by 5°x5° latitude-longitude grids (CATDIS), however back in time there is limited information on the actual location of the catches.

Figures 3 and 4 and Table 1 show the spatial distribution (5x5 lat-lon) of the West bluefin tuna stock unit in the 1960's and in the 1970's as estimated by CATDIS. After the huge catches in the area between 0 and 10 latitude south in 1963 and 1964 were observed, the catches in this area became much smaller.

Considering the area analyzed by Takeuchi *et al.* 1999 and the current OM area structure that combines the catch in the Caribbean Sea to the West Atlantic, it was suggested to use catches between 20 N latitude and 20 S latitude in the West stock area for the "Brazilian episode". The high catches in this area were observed from 1962 to 1965 (**Figure 5**). To cover enough time period, it is suggested to use catches between 1950 and 1970 for the robustness test.

Table 2 and Figure 6 show the current catches in Task 1 under the current hypothesis for the west and east bluefin tuna stocks. For the robustness test, it was suggested that the following catches will be reallocated from the west stock to the east stock units:

- a) Catches between 1950 and 1970.
- b) Catches between 20 N latitude and 20 S latitude in the West stock area.
- c) All flags and gears, remove minor catches (< 10 t in total) if the catches occurred only for a several years.

Regarding size distribution of the "Brazilian episode" catch, there is very limited information. For the OM input data, catch at age by quarter and year before 1964 is required while only quarterly catch is required after 1965, but the size information is very scarce and only the lengths for 5 fish are available before 1970. To produce catch at length and finally to convert to catch at age, it was assumed that the size of bluefin in the area was similar to the one in the West Atlantic (OM area 2) in the year 1973 to 1978. The estimated catch at length was converted using the ALK for the West stock (delivered from growth curve with 25cm bin in the BFT MSE package) (Kimoto *et al.*, 2019).

3. Results and discussion

Overall the ‘Brazilian episode’ catches represent 19,394 t of fish in the period between 1957 and 1970 that are moved from the West Atlantic (OM area 2 WATL) to the East Atlantic (OM area 4 SATL) (**Table 3 and Figure 7**). At the peak of the episode in 1964, the total of 8,660 t represents about 47% of the total West BFT catch. This estimated catch matched to the one used in Fromentin *et al.*, 2014 (**Figure 8**).

The catches between 1950 and 1970 in the area between 20° N latitude and 20° S latitude took 22 % of the total catch in the entire West stock area (**Table 4**), while it was 1% for the catch after 1970. The high catches (more than 1200 t) in this area were observed from 1962 to 1965 (Figure 5). The major area for the West BFT catches is the north of 20° N latitude (Table 3 and Figure 5). After removing the minor catches less than 10 t (9.4 t in 1968, and 6.5 t in 1969 by Chinese Taipei longline), the catches were composed by only Japanese longline.

The quarterly catch between 1950 and 1970 is available in Table 5, and these were reallocated to the East Atlantic for this robustness test. The size distribution of the “Brazilian episode” catch was assumed to be similar to the ones in the West Atlantic used in the calculation for a reference set (Kimoto *et al.*, 2019). The assumed length compositions are shown in Figure 9 only come from Japanese longline, and are mainly 220 cm to 280 cm (**Figure 9**). The estimated catch by quarter before 1964 was converted to catch at age for the robustness test input.

All analyzed files are available in the Owncloud Analysis folder for the second BFT MSE Technical Group meeting in September 2020. Main summaries are available in “OffBrazil_Check2020Aug_rev.xlsx”. The final OM input files for the robustness test are “Cobs_JPLLsplit_BRARobustness.csv” and “HCobs5064_final_BRARobustness.csv”. Comparisons of catches by OM area for a reference set and this robustness test is available in “comparisons_offBrazil.xlsx” and “HCob_BRARobustness_Aug2020.xlsx” is for creating catch at age before 1964.

References

- Anon. 2020. Report of the 2020 SCRS Advice to the Commission.
- Fromentin J.M. and J.E. Powers. 2005. Atlantic bluefin tuna: population dynamics, ecology, fisheries and management. *Fish and Fisheries* 6: 281- 3006.
- Fromentin J.M. and Reygondeau G, Bonhommeau S., and Beaugrand G. 2014. Oceanographic changes and exploitation drive the spatio-temporal dynamics of Atlantic bluefin tuna (*Thunnus thynnus*). *Fisheries Oceanography* 23(2): 147- 156.
- Kimoto A., Carruthers T., Walter J.F., Mayor C., Hanke A., Abid N., Arrizabalaga H., Rodríguez-Marín E., Palma C., and Ortiz M. 2019. Summary of input data (catch, size and indices) used in the Atlantic bluefin tuna Operating Models (version 5.2.3). Coll. Vol. Sci. Pap. ICCAT 76(1): 144-164.
- Takeuchi Y., A Suda and Z. Suzuki. 1999. Review of information on large bluefin tuna caught by Japanese longline fishery off Brazil from the late 1950's to the early 1960's. Coll. Vol. Sci. Pap. ICCAT 49(2): 416-428.
- Takeuchi Y., K. Oshima and Z. Suzuki. 2009. Inference on nature of Atlantic bluefin tuna off Brazil caught by the Japanese longline fishery around the early 1960's. Coll. Vol. Sci. Pap. ICCAT 63: 186-194.

Table 1. The estimated decadal catch of bluefin tuna by aggregated 5 x 5 grid in the West Atlantic in the 1960's and the 1970's.

1960s			Longitude														
location			-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25
			-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30
Latitude	45	50								30		1853					
	40	45							12635	2774	38	21	76	89			
	35	40						1228	12003	118	14	12	5	28			
	30	35					56	7763	2748	417	76	108	23	23			
	25	30	3	2459	24			9244	498	71	88	6	2	9			
	20	25	1	22	13			2	126	227	171	22	13	12			
	15	20	1	0			3	3	1	29	111	138	24	10			
	10	15					0	1	1	2		20	105	24			
	5	10										1	19	194	151	579	
	0	5											0	54	627	1548	1520
	-5	0													1	2587	4802
	-10	-5														53	4695
	-15	-10														203	647
	-20	-15														98	270
	-25	-20															81
	-30	-25													7	16	11
	-35	-30												2	16	21	8
	-40	-35											164	53	52	17	
	-45	-40											451	95	48	13	1
														0			0

1970s			Longitude														
location			-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25
			-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30
Latitude	45	50							314	2262	0	479	6				
	40	45							9035	2411	3363	389	2086	982			
	35	40						795	12812	3065	899	2	38	42			
	30	35				63		135	89	11	8	5	2	3			
	25	30	114	4490	4401	78	6005	3	0				0				
	20	25	15	6	18			7	21	8	0	1					
	15	20					1	0	21	30	2	9					
	10	15						73	50	1	16	1	1	1			
	5	10										4	1	15	15	9	
	0	5												6	19	12	34
	-5	0														0	5
	-10	-5														5	6
	-15	-10														1	1
	-20	-15														1	6
	-25	-20													0	0	2
	-30	-25												0	17		4
	-35	-30											22	7	2		0
	-40	-35										0	10	12	3	2	0
	-45	-40											0		1	7	4

Table 2. Total bluefin catch (Task 1) by stock in the period between 1950 and 2019.

Year	West BFT	East BFT
1950	1,017	26,812
1951	1,123	30,211
1952	694	39,007
1953	1,084	39,275
1954	823	37,157
1955	544	44,092
1956	247	30,186
1957	546	35,873
1958	1,207	33,353
1959	1,649	26,334
1960	1,032	26,113
1961	1,620	28,083
1962	5,799	29,457
1963	13,838	16,357
1964	18,608	17,208
1965	14,167	17,095
1966	8,080	15,084
1967	5,940	19,734
1968	3,176	13,545
1969	3,012	15,024
1970	5,466	10,808
1971	6,591	11,185
1972	3,948	10,830
1973	3,871	11,012
1974	5,390	19,285
1975	5,072	21,465
1976	5,880	22,368
1977	6,695	18,980
1978	5,765	15,115
1979	6,255	12,435
1980	5,784	14,059
1981	5,770	14,105
1982	1,660	22,421
1983	2,554	21,699
1984	2,301	24,473
1985	2,680	22,063
1986	2,329	19,260
1987	2,504	18,271
1988	2,902	24,129
1989	2,766	21,161
1990	2,782	23,599
1991	2,929	26,389
1992	2,296	31,831
1993	2,384	34,258
1994	2,113	46,769
1995	2,448	47,303
1996	2,512	51,497
1997	2,334	51,211
1998	2,657	50,000
1999	2,772	50,000
2000	2,775	50,000
2001	2,784	50,000
2002	3,319	50,000
2003	2,305	50,000
2004	2,125	50,000
2005	1,756	50,000
2006	1,811	50,000
2007	1,638	61,000
2008	2,000	24,460
2009	1,980	19,818
2010	1,857	11,338
2011	2,007	9,774
2012	1,754	10,934
2013	1,482	13,243
2014	1,627	13,261
2015	1,842	16,201
2016	1,901	19,131
2017	1,850	23,616
2018	2,027	27,757
2019	2,305	28,760

Table 3. Total bluefin catch by stock in the period between 1950 and 2019, after moving the West BFT catches in the area between 20N and 20S latitude to the East Atlantic.

Year	West BFT removed	East BFT added
1950	1,017	26,812
1951	1,123	30,211
1952	694	39,007
1953	1,084	39,275
1954	823	37,157
1955	544	44,092
1956	247	30,186
1957	516	35,903
1958	1,175	33,385
1959	1,449	26,534
1960	693	26,452
1961	1,247	28,456
1962	4,587	30,670
1963	7,841	22,354
1964	9,948	25,868
1965	11,839	19,423
1966	7,942	15,222
1967	5,890	19,784
1968	3,167	13,554
1969	2,998	15,038
1970	5,455	10,819
1971	6,591	11,185
1972	3,948	10,830
1973	3,871	11,012
1974	5,390	19,285
1975	5,072	21,465
1976	5,880	22,368
1977	6,695	18,980
1978	5,765	15,115
1979	6,255	12,435
1980	5,784	14,059
1981	5,770	14,105
1982	1,660	22,421
1983	2,554	21,699
1984	2,301	24,473
1985	2,680	22,063
1986	2,329	19,260
1987	2,504	18,271
1988	2,902	24,129
1989	2,766	21,161
1990	2,782	23,599
1991	2,929	26,389
1992	2,296	31,831
1993	2,384	34,258
1994	2,113	46,769
1995	2,448	47,303
1996	2,512	51,497
1997	2,334	51,211
1998	2,657	50,000
1999	2,772	50,000
2000	2,775	50,000
2001	2,784	50,000
2002	3,319	50,000
2003	2,305	50,000
2004	2,125	50,000
2005	1,756	50,000
2006	1,811	50,000
2007	1,638	61,000
2008	2,000	24,460
2009	1,980	19,818
2010	1,857	11,338
2011	2,007	9,774
2012	1,754	10,934
2013	1,482	13,243
2014	1,627	13,261
2015	1,842	16,201
2016	1,901	19,131
2017	1,850	23,616
2018	2,027	27,757
2019	2,305	28,760

Table 4. The summary table of catch by zone ($\geq 20N$, $20N-20S$, $<20S$, and the entire area) in the West Atlantic or by period (before and after 1970, and the whole period).

	West(North of 20N)	West(20S-20N)	West(South of 20S)	all West area
1950-1970	69270	19410	992	89672
1971-2016	139165	1571	170	140905
1950-2016	208435	20980	1162	230577

Table 5. Estimated quarterly catch at age of “Brazilian episode”, used for the robustness test.

Year	Quarter	Catch
1958	1	15.28
1959	1	139.39
1960	1	26.69
1961	1	180.21
1962	1	133.85
1963	1	900.08
1964	1	3894.22
1965	1	1303.08
1966	1	60.33
1967	1	0.59
1969	1	0.80
1970	1	10.19
1957	2	3.39
1958	2	13.42
1959	2	15.79
1960	2	123.46
1961	2	29.20
1962	2	276.07
1963	2	4479.99
1964	2	4469.33
1965	2	1000.88
1966	2	74.88
1967	2	15.40
1968	2	3.25
1969	2	11.74
1970	2	0.94
1957	3	0.26
1959	3	1.94
1960	3	19.84
1961	3	4.19
1962	3	109.92
1963	3	86.23
1964	3	31.88
1965	3	6.27
1966	3	1.48
1967	3	19.15
1968	3	4.97
1969	3	0.97
1957	4	26.35
1958	4	3.30
1959	4	42.74
1960	4	169.02
1961	4	159.40
1962	4	692.57
1963	4	530.79
1964	4	264.90
1965	4	17.85
1966	4	1.70
1967	4	14.41
1968	4	0.38
1969	4	0.64

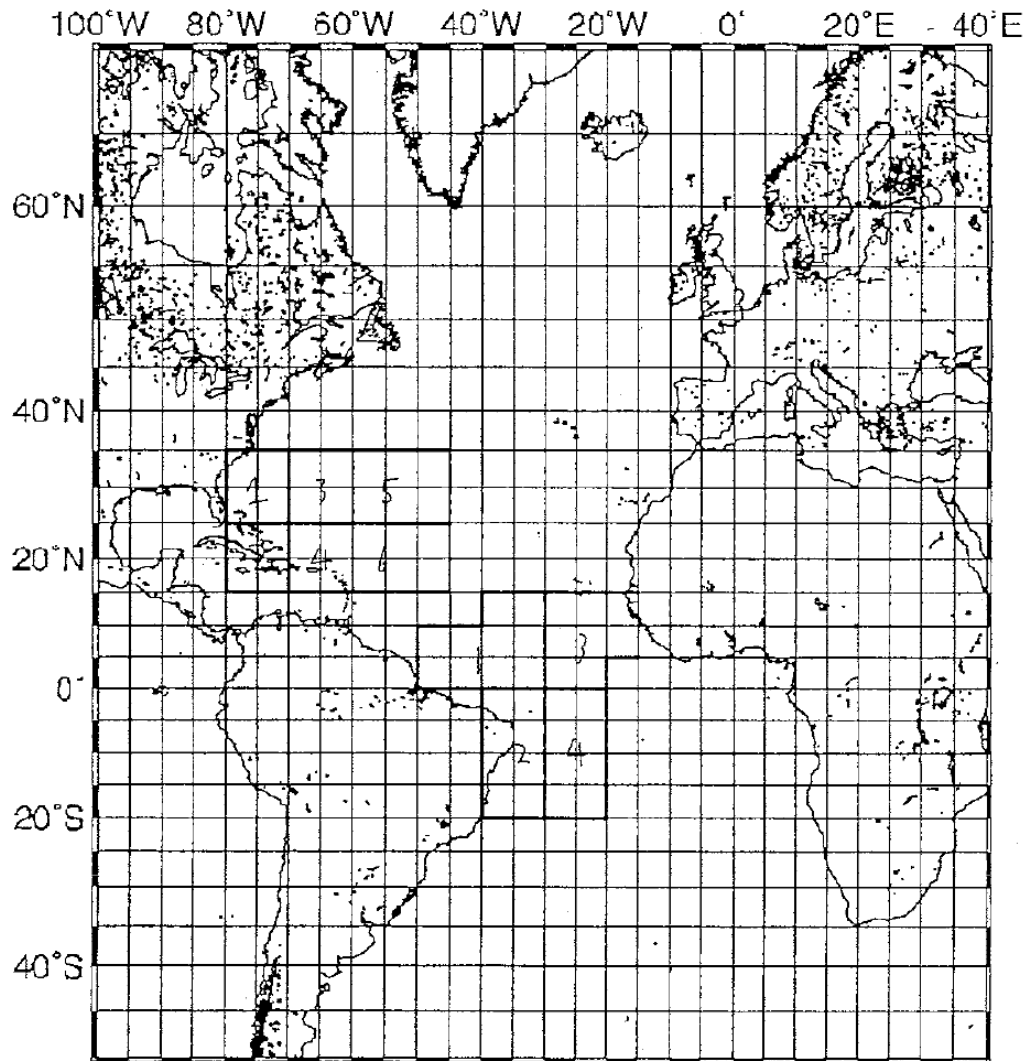


Figure 1. Area used in the analysis by Takeuchi *et al.*, 1999 of off Brazil and off Florida data. (Figure 5 in SCRS/1998/085)

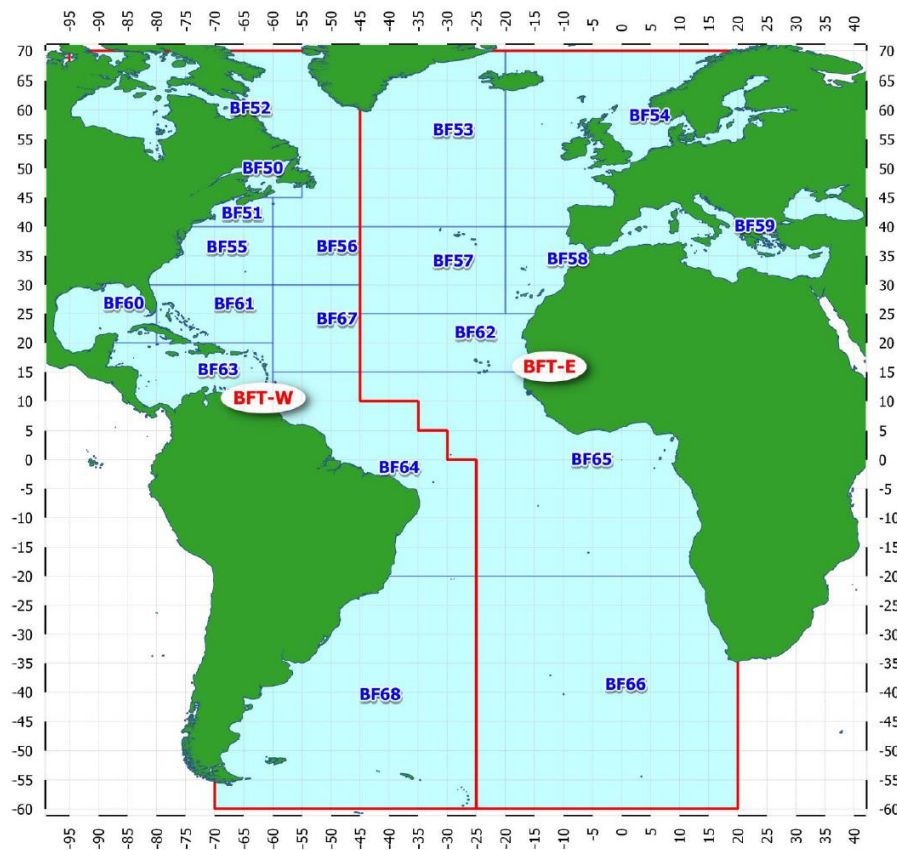


Figure 2. ICCAT current definition of the stock boundaries for Atlantic bluefin tuna (red lines) and the corresponding sampling areas for fisheries statistics reports (BF codes).

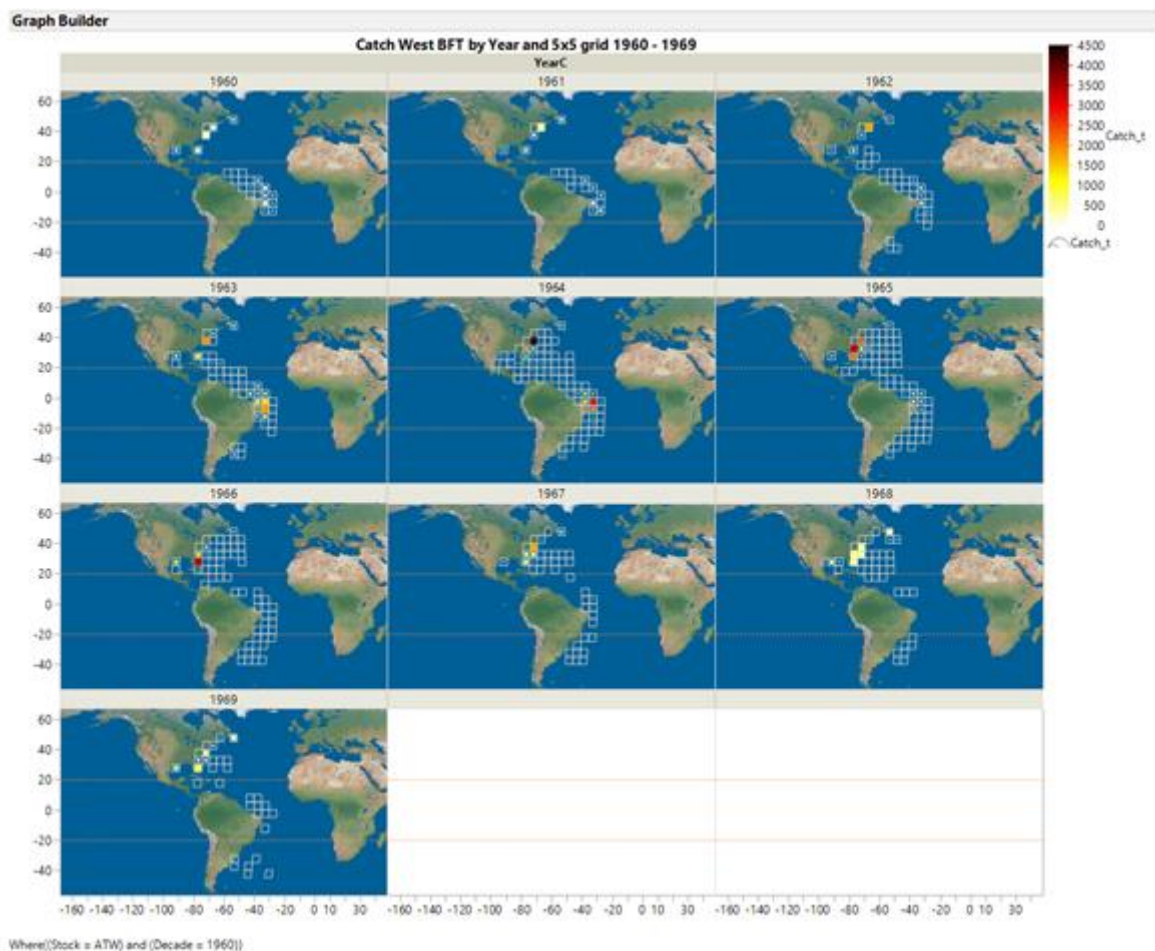


Figure 3. Annual spatial distribution (5x5 lat-lon) of the West bluefin tuna stock unit in the 1960's as estimated by CATDIS.

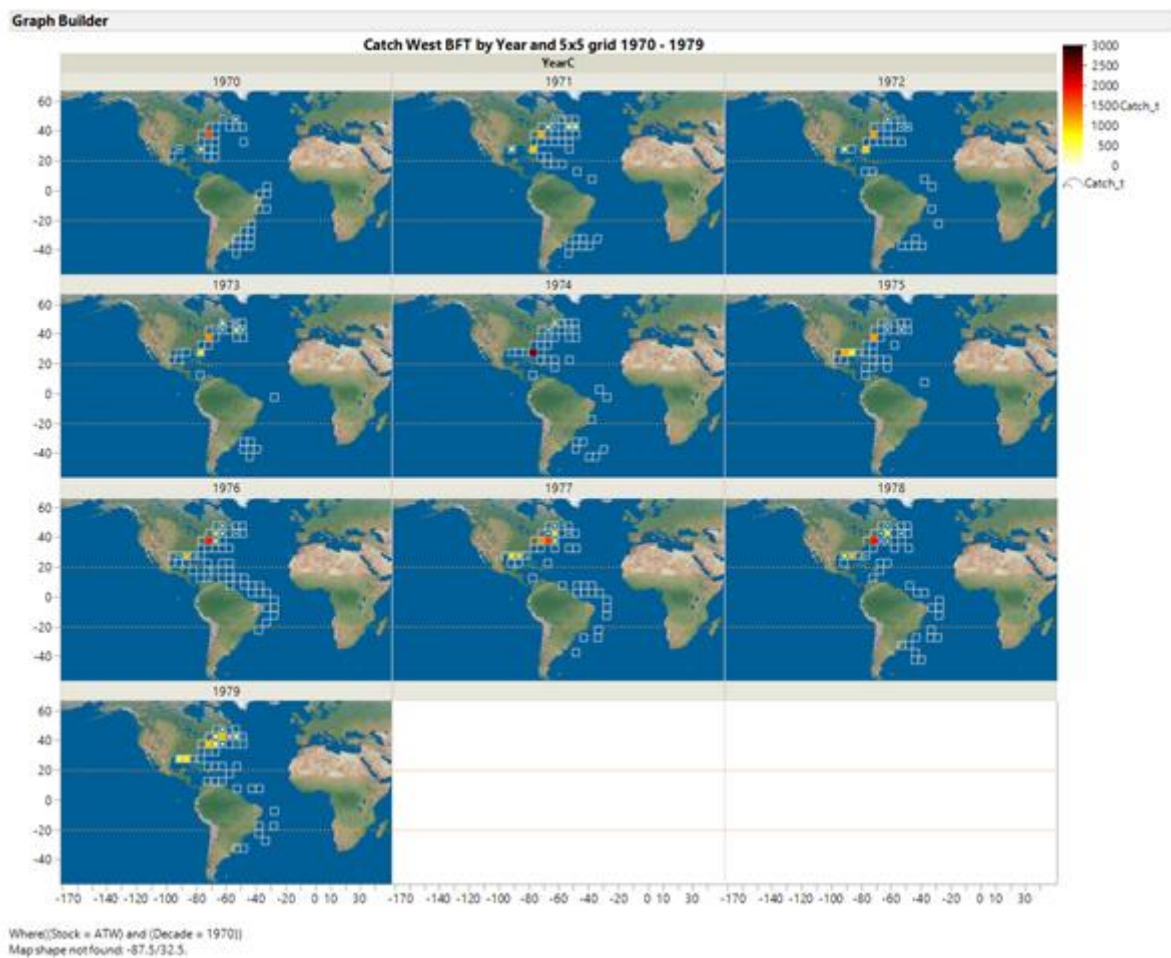


Figure 4. Annual spatial distribution (5x5 lat-lon) of the West bluefin tuna stock unit in the 1970's as estimated by CATDIS.

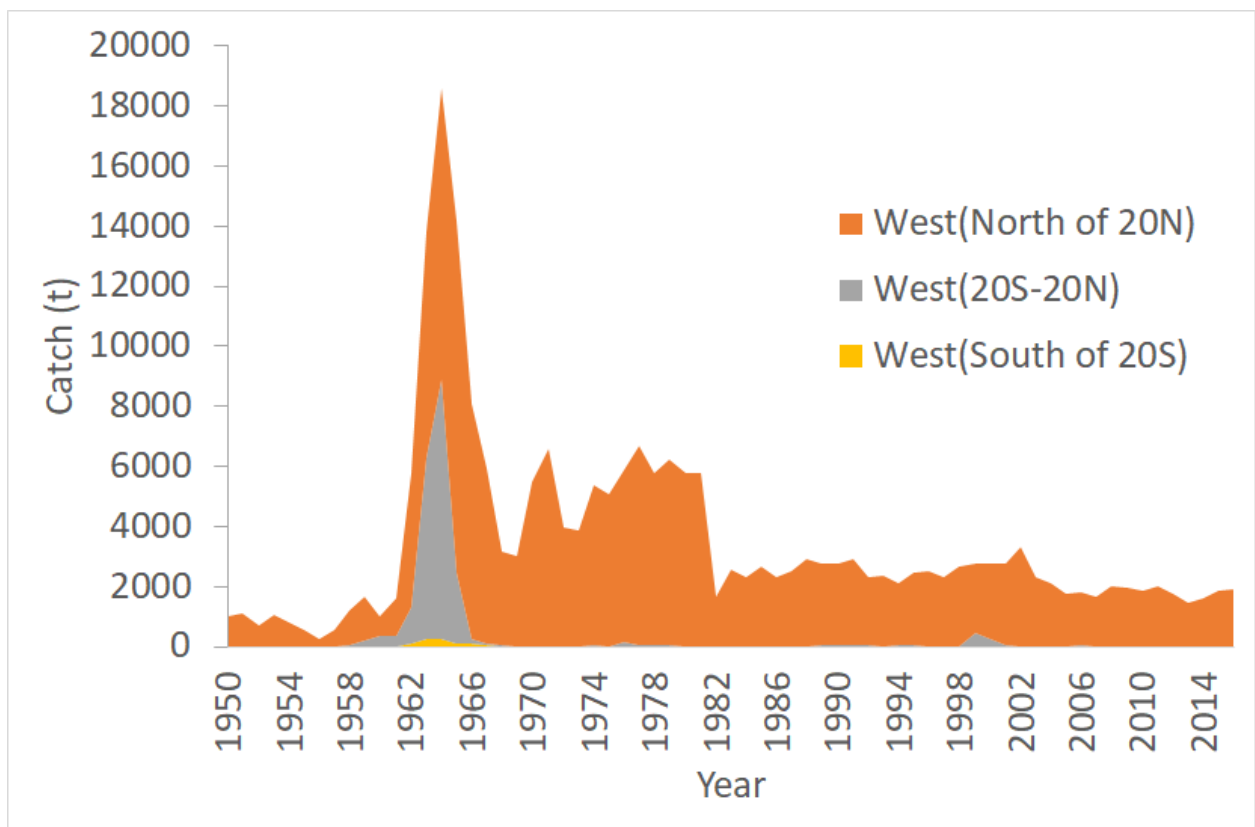


Figure 5. The West BFT catch by zone (North of 20N, 20S-20N, South of 20S) in 1950-2016 using CATDIS.

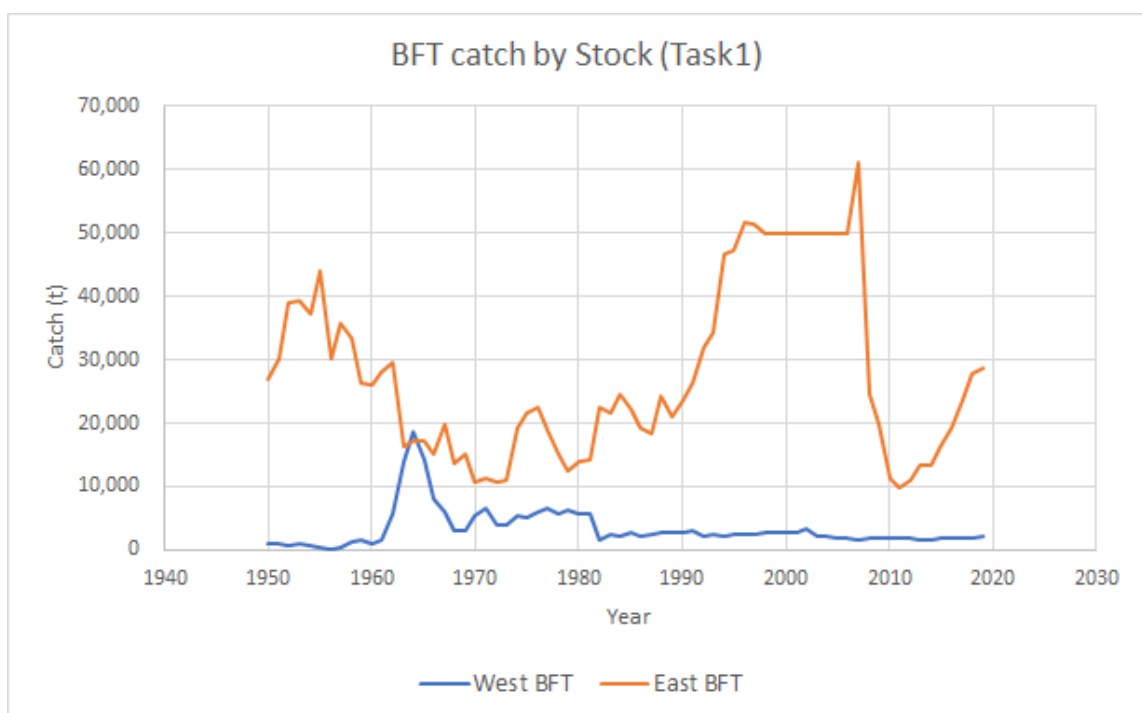


Figure 6. Total bluefin catch (Task 1) by stock used in an OM reference set in the period between 1950 and 2016.

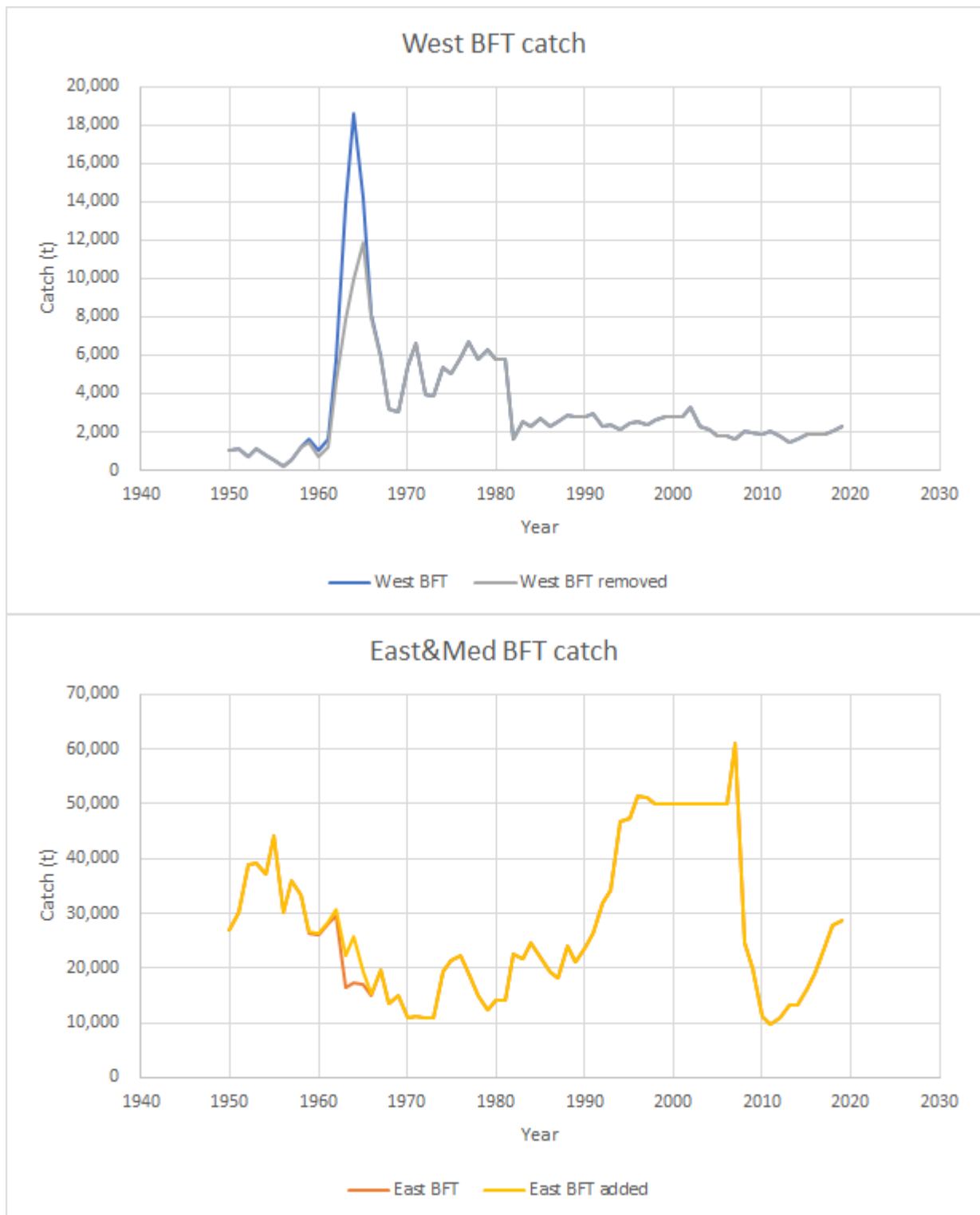


Figure 7. Total bluefin catch by stock in the period between 1950 and 2019, after moving the West BFT catches in the area between 20N and 20S latitude to the East Atlantic. The grey line for the West catch (above) and the yellow line for the East catch (bottom) are used in the robustness test for the “Brazilian episode”.

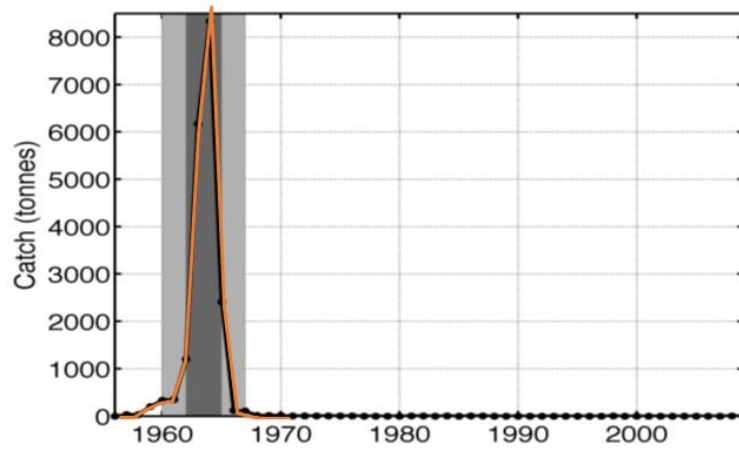


Figure 8. Comparisons of the estimated catch for “Brazilian episode” between this study and Fromentin *et al.*, 2014.

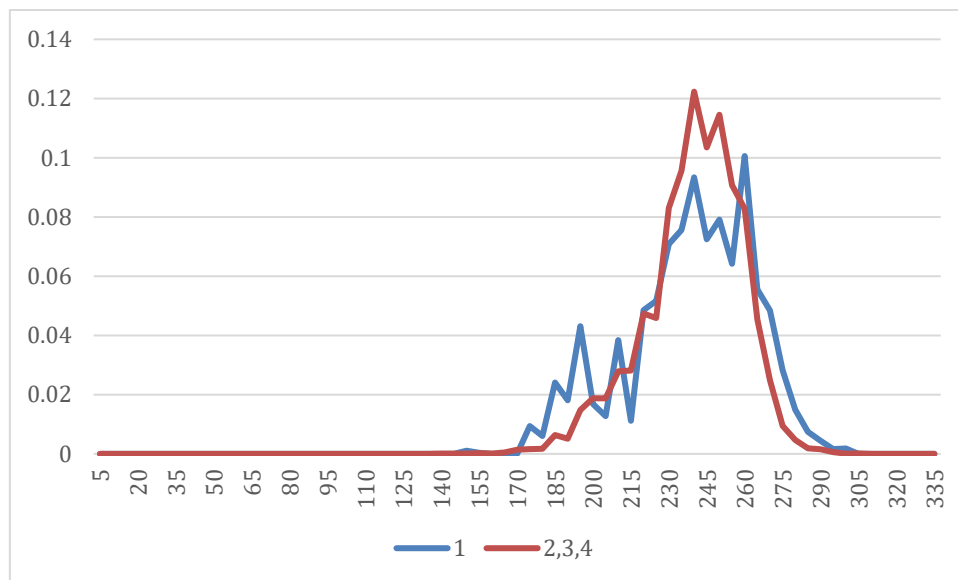


Figure 9. Assumed length composition for the catch of “Brazilian episode” for the 1st quarter (blue) and for the rest of quarters (red). The label of length shows its lower limit of 5 cm bin.